DOCUMENT RESUME

ED 058 771 FL 002 813

AUTHOR	Carroll, John B.
TITLE	Learning from Verbal Discourse in Educational Media: A Review of the Literature. Final Report.
INSTITUTION	Educational Testing Service, Princeton, N.J.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C.
REPORT NO	RB-71-61
BUREAU NO	BR-7-1069
PUB DATE	Oct 71
CONTRACT	OEC-1-7-071069-4243
NOTE	293p.
EDRS PRICE	MF-$0.65 HC-$9.87
DESCRIPTORS	Bibliographies; Cognitive Processes; *Comprehension; Connected Discourse; Instructional Media; *Language Research; *Learning; Learning Characteristics; Learning Theories; *Literature Reviews; Measurement Techniques; Media Research; Memory; Psychology; Readability; Retention; Unwritten Language; *Verbal Communication; Verbal Learning; Written Language

ABSTRACT

This review, based on a survey of more than 1200 items in the research literature, begins by attempting to outline a theory of language comprehension and learning from language. A lengthy chapter is devoted to problems in the measurement of comprehension and of learning from connected discourse. Also considered, in successive chapters, are the role of various kinds of factors in promoting comprehension and learning from connected discourse--stimulus characteristics such as readability, listenability, vocabulary, grammatical structure, and logical organization-stimulus modality (audition vs. vision); manner of presentation; factors in learning and memory; and individual differences. Problems for further research are pointed out. (Author)

ED 058771

RESEARCH BULLETIN

RB-71-61

LEARNING FROM VERBAL DISCOURSE IN EDUCATIONAL MEDIA: A REVIEW OF THE LITERATURE

John B. Carroll

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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This was submitted to the U. S. Office of Education in January 1971 as the Final Report for Project No. 7-1069, Contract No. 1-7-071069-4243. It has been approved by the U. S. Office of Education for publication and is therefore being included in the Research Bulletin series to facilitate dissemination.

FL002 813

Educational Testing Service
Princeton, New Jersey
October 1971

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PREFACE

The idea of writing an overview and assessment of the research literature on the comprehension of meaningful verbal discourse in educational media originated in 1965 with a Study Panel, of which I was a member, established under Title 7 of the National Defense Education Act of 1958. The members of the Study Panel felt that such a review would be useful to educational planners and policy-makers, researchers, and designers of instructional materials. I was persuaded to undertake this review, but at the time, neither I nor the other members of the panel had a realistic idea of the dimensions of the task. That the literature of this field is so enormous and that relevant work is going on in such a wide variety of domains is in itself a finding that justifies the assignment.

The time, staff, and budget requested for this project was grossly underestimated. Extensive as this report and the accompanying bibliography is, circumstances have forced me to compromise my standards, and I would be the first to admit that the report is somewhat superficial at many points. The bibliographical search could have been expanded in many directions, and there could have been a more thorough examination and critique of the literature in certain areas. Major emphasis has been placed on literature produced in the period 1961-1970, but much selectivity had to be exercised because of the large amount of material available. Undoubtedly I have missed a number of important items.

It is my hope that this document will to some extent serve the function that is the objective of any survey of this kind--to organize the present state of our knowledge into a framework such that duplication

and redundancy in research will be reduced, ongoing research can be facilitated, and contemplated research can take note of the gaps and neglected areas that have become apparent in the process of mapping the terrain.

Miss Mary Harcar, a Research Assistant at Educational Testing Service during 1968-1969, was of much help in the early phases of assembling the bibliography. I am grateful to her, as well as to the typing, clerical, and editing personnel at ETS who assisted in putting the report together.

John B. Carroll

SUMMARY

This review, based on a survey of more than 1200 items in the research literature, begins by attempting to outline a theory of language comprehension and learning from language. A lengthy chapter is devoted to problems in the measurement of comprehension and of learning from connected discourse. It then considers, in successive chapters, the role of various kinds of factors in promoting comprehension and learning from connected discourse: stimulus characteristics such as readability, listenability, vocabulary, grammatical structure, and logical organization; stimulus modality (audition vs. vision); manner of presentation; factors in learning and memory; and individual differences. Problems for further research are pointed out.

Chapter 1

INTRODUCTION AND SCOPE

Even in various educational media such as films, television, and programmed instruction, by far the largest amount of teaching activity involves "telling things" to students, whether by speech or the printed word. A picture is usually meaningless without a caption, and most educational films would be only minimally intelligible without sound track or titles. In instructional television, it is common practice for the lecturer to perform as if he were in a classroom. Programmed instruction makes liberal use of verbal messages. It seems obvious that meaningful verbal discourse (MVD) is the primary tool of teaching. We expect students to learn most things by being told about them.

It is the purpose of this review to bring together, and to interpret, for their possible utility in the preparation and use of educational media, available research findings concerning how pupils understand, learn, and remember the content of MVD. The review will also identify gaps in the research literature and point out problems for further research.

The scope of the review can perhaps best be indicated by starting from what Schlesinger (1966b, p. 227) calls a "faceted" definition of communicability research. According to him, communicability is

the $\left\{\begin{matrix}\text{ease}\\ \\ \text{readiness}\end{matrix}\right\}$ with which linguistic material in $\left\{\begin{matrix}\text{written}\\ \\ \text{spoken}\end{matrix}\right\}$ form with (given) $\left\{\begin{matrix}\text{cognitive}\\ \\ \text{emotional}\end{matrix}\right\}$ characteristics of $\left\{\begin{matrix}\text{content}\\ \\ \text{style}\end{matrix}\right\}$ is $\left\{\begin{matrix}\text{decoded}\\ \\ \text{encoded}\end{matrix}\right\}$ by members of a (given) population. The faceted definition may be read, then, in $2^5 = 32$

ways by taking each member of a pair in combination with selections of one term in each of the other pairs. In the pair $\left\{\begin{matrix}\text{ease} \\ \\ \text{readiness}\end{matrix}\right\}$, ease focuses attention on the characteristics of the material, whereas readiness refers to characteristics of language users.

By including the pair $\left\{\begin{matrix}\text{decoded} \\ \\ \text{encoded}\end{matrix}\right\}$ Schlesinger embraces both problems of understanding and production. The present review is not concerned with problems of how people produce language (except incidentally in connection with the problems of how appropriate instructional materials can be produced). It is concerned essentially with how people (more specifically, pupils or students) decode linguistic material, i.e., understand it, and more than that, how they learn and remember the content of the material. Let us, therefore, adapt Schlesinger's definition to our purposes by deleting the word "encoded."

But we must add several phrases in order to delineate the complete scope of this review. The ease or readiness with which linguistic material is understood depends not only upon some of the factors already mentioned in Schlesinger's definition but also upon at least two other important factors: (1) the supporting context of the message, e.g., the immediate physical environment, the speaker-hearer relationship, or a still or moving picture that illustrates some aspect of the message, and (2) the manner of its presentation, e.g., whether fast or slow, in a single presentation or in repeated presentations, with or without feedback of information concerning the student's response to the material, etc. A description of what this review intends to cover can therefore be stated as:

the {ease / readiness} with which linguistic material in {spoken / written} form with (given) {cognitive / emotional} characteristics of {content / style}, presented in a (given) manner, {with / without} supporting context, is decoded (understood, learned, remembered) by members of a (given) population. By "ease" of decoding (understanding, learning, remembering) we mean the degree to which there is understanding, learning, or remembering on the part of the student. By "readiness" we mean the degree to which the student is able to understand, learn, or remember, as a function of his aptitudes, previous experiences, likes, preferences, goals, etc., interacting with the content and style of the message. We will deal with both spoken and written messages; we will address ourselves mainly, however, to their cognitive rather than to their emotional characteristics, but we will deal with factors of both content and style. Presentation and contextual factors will be given attention. We discuss later (Chapter 3) what may be meant by "decoding," "understanding," "learning," and "remembering." The populations with which we will be concerned are primarily populations of school learners, at any age from the kindergarten to adulthood.

This review will focus on how people learn from language, not on how they learn language. While an attempt is made to point out the particular problems in learning from language presented in "educational media," actually the focus is upon learning from language in any context, the classroom, the study, the library, or whatever. The only special characteristic of educational media that is of interest here is the fact that ordinarily they present highly

standardized, controlled, and repeatable sequences of verbal discourse. (One can show a film a number of times, whereas a teacher's verbal output will normally differ from occasion to occasion.) In fact, most of the research literature on instructional film and television seems to indicate that use of these media produces very much the same degree of learning as direct instruction. Much of this review will cover findings from the experimental laboratory or from observational settings where there were no special "educational media" other than perhaps a blackboard and chalk, or a textbook.

It may be asked, why study learning from verbal discourse? Most of us live in an environment constantly filled with meaningful verbal discourse, and we think we understand all or most of it. In the first place, the MVD that we are most accustomed to and believe we nearly always understand is what may be called "everyday speech." The German language, in fact, has a special term for this kind of language: Umgangssprache. The reader may be reminded, however, that many kinds of language we encounter in daily life--editorials in newspapers, certain public speeches, etc.--may not be as readily understood as everyday speech. Secondly, as educated adults we may fail to appreciate the enormous variations in understanding of language, on the part of children or of less educated adults. An examination of the results of almost any reading or listening comprehension test will convince one that the average level of performance in understanding verbal discourse that departs from everyday language is far from justifying any assumption that pupils understand everything they hear or read. But these comprehension tests usually measure only immediate understanding of language materials after one presentation; any teacher knows that even if the child understands something upon its first presentation, this does not mean that he will retain

it over long periods. Therefore, we must study not only language comprehension but also the phenomena of learning and retention.

Obviously, some of the failure to comprehend and retain the contents of verbal discourse may be attributed to the child's lack of maturity and education; the child fails to understand because at the time he is tested he has not learned enough about language and the world about him. Ordinarily, teachers attempt to choose educational media that are appropriate to the educational level of their classes, but it is not always easy or possible to do so; even if there were sure guides to assessing the verbal difficulty of educational materials teachers would still face the fact of considerable heterogeneity of verbal ability in their classes.

It is the basic premise of the present review that pupils' failures in comprehension (and retention, insofar as comprehension is a prerequisite for it) are due at least in part to the characteristics of educational materials themselves or to the ways in which they are presented and used. Verbal discourse in educational media, besides being sometimes of inappropriate difficulty level for the intended audiences, is often needlessly complex, poorly organized, and poorly presented. I have tried to point out how research literature suggests ways to improve the preparation and presentation of verbal discourse in educational media, and how there can be more adequate matching of educational material and media with student capacity to profit from these materials. The literature will be considered under the following headings:

a. Message and message source variables, i.e., variables having to do with the content of the message, its phraseology, style, and construction, and its source. (See Chapter 4)

b. Stimulus modality factors, i.e., whether presentation is auditory, visual, or audiovisual, and whether it is combined with other types of presentations (e.g., pictorial) that provide supporting context. (See Chapter 5)

c. Presentation factors, i.e., factors having to do with rate, frequency, mode, and structuring of presentations. (See Chapter 6)

d. Phenomena of learning and retention. (See Chapter 7)

e. Student factors, i.e., variables concerned with the characteristics and the educational background of the student. (See Chapter 8)

The potential scope of any thoroughgoing treatment of learning from verbal discourse is enormous; it covers large areas of the psychology of learning and the psychology of language. I must impose certain limits upon the present treatment:

a. In specialized areas that have already been covered by published reviews, I will present only the major conclusions of these reviews, with any additional updating and interpretation that may seem appropriate.

b. Attention will be focused on learning from MVD that is intended to instruct or at least to inform. Little attention will be paid to MVD that is primarily intended to <u>persuade</u> students or to change their attitudes, except to the extent that the informative function of such discourse is also recognized.

c. Attention will be restricted largely to MVD put forth by a single source, in contrast to MVD that arises in the course of a dialogue or a sequence of classroom interactions. Thus, I will be concerned usually with "one-way" communication from a source to a pupil or group of pupils.

d. I shall not be concerned with problems of language acquisition or with learning to read. That is, the research to be reviewed here generally assumes that the pupil is already "competent" to recognize the elementary units and patterns of a meaningful verbal discourse, whether it be in spoken or written form. It is difficult to state this assumption precisely, because there is always the possibility that even though the student "knows the language" and "can read" (in the sense of being able to decode printed words into their spoken counterparts), his failure to comprehend a particular discourse may stem from his lack of knowledge of particular words or syntactical patterns contained in it. Thus, I will consider problems of language acquisition and comprehension that arise beyond the stage of "primary language acquisition" or of "beginning reading."

e. I shall not be concerned with problems of auditory or visual deficiencies, or with conditions under which messages are presented with low signal-to-noise ratio or poor fidelity, poor illumination or viewing, etc. That is, the research to be considered here assumes that the pupil is capable of hearing or seeing the message, and that the conditions under which

the message is presented enable him to do so with no essential loss of information. It is often the case, of course, that educational media that present MVD are poorly seen or heard, but conditions that result in such poor seeing or hearing (with any consequent loss of comprehension or learning) are not within the scope of this review.

Previous Reviews of Learning from MVD

It is my intention to prepare a review that will overlap minimally, with other reviews of problems in learning from educational media that have been prepared for the NDEA Title VII Study Committee (May 1965a, 1965b, 1966; Briggs, 1967) or a review by Travers (1967) of certain problems in audio-visual education. Nevertheless, I wish to point out the relation of this review to certain other interpretive literature summaries.

The general problem of learning from MVD seems never to have been subjected to a thoroughgoing literature review. There are, of course, many reviews and even whole textbooks devoted to the psychology of learning in general or to particular aspects of it, but with a few exceptions (e.g., Ausubel, 1963, 1968), these have not considered specifically the subject of learning from MVD. The characteristic approach of psychologists to problems of learning has been to attempt to deal with it in terms of general principles, drawing heavily from the literature on animal learning and on human learning of nonsense syllables or arrays of single isolated words. Insofar as certain general principles may have relevance for the learning of MVD they cannot be ignored or dismissed, but discourse learning presents certain special problems for theoretical and general psychology that have been for the most part

overlooked or sidetracked. (The nature of these problems will be described and elaborated in Chapter 2.) For example in Keppel's (1964) review of "verbal learning" in children, any problem relating to "verbal or language behavior" is specifically excluded, verbal learning being defined to refer only to learning of nonsense syllables, word lists, and the like.

This is not to say, of course, that phenomena having to do with the learning of or from meaningful verbal discourse have escaped the attention of psychologists. A paragraph memory test, in which the subject was required to listen to a short paragraph and then repeat it verbatim, was a component of early intelligence tests (Binet and Simon, 1908; Terman, 1916). William James (1890, Vol. I, pp. 280-283) wrote of the subjective phenomena involved in understanding a sentence. Early experiments on the learning of connected discourse were performed by Henderson (1903) and Lyon (1917). The first full review of research literature in this area appears to have been the one by Welborn and English (1937), who were concerned mainly with the differences between what they called "verbatim" and "logical" learning. (Roughly, "verbatim" learning is learning of a discourse, i.e., its exact words, while "logical" learning is learning <u>from</u> a discourse, i.e., its content and ideas.) Stroud (1940) touched on certain problems of MVD learning in his review of research in school learning. Although a number of psychologists have mounted research programs on learning from MVD (e.g., Cofer, 1941, 1956) there appears to have been no major literature review of findings since the Welborn and English review cited above. There have been some important writings in this field by Ausubel (1963, 1968) but they do not provide

comprehensive literature reviews and are devoted to the exposition of a particular theoretical position. There is a highly useful summary by Petrie (1963) but it is restricted to studies of "informative speaking" and does not provide a detailed analysis of the literature. Reviews of "readability" and listenability research by Chall (1958) and Klare (1963) are helpful but concern themselves largely with certain message style variables in comprehension. Travers (1967) has reviewed literature bearing on the comparative efficiency of auditory and visual presentations of MVD, but his concern is mainly with problems of information transmission and channel capacity. The summary of studies in instructional television and film that was prepared by Reid and MacLennan (1967) is useful but is not focused on the particular problem of learning from MVD.

In the published literature, then, there seems to be no comprehensive review of work on learning <u>of</u> or <u>from</u> MVD.

Chapter 2

SOME THEORY

At the highest level of abstraction and yet simplicity, we may say that learning from meaningful verbal discourse takes place when some more or less permanent change occurs in a person's conceptual structure as a result of his having received a verbal message, with the proviso that this change of conceptual structure has some sort of veridical connection with the content of the message. For example, when a person hears the message "Your house is on fire" we may suppose that he has "learned" from this message if he now "knows" that his house is on fire, or at least entertains a belief in the possibility that his house is on fire. His knowledge or belief about the state of his house is, presumably, a change in his conceptual structure, since he did not previously know or believe that his house was on fire. Any further response he may make, such as running to sound an alarm, or perchance saying "I'm delighted" (if he hoped all along it would burn down), is irrelevant to the fact of learning. Now of course, he may have already become aware from another source that his house was on fire, in which case the only change in his conceptual structure is his knowledge of the fact that his informant knows this too and felt impelled to tell him. In this latter case, we would probably say that there was no learning, at least no learning of the content of the message, and it is to exclude such a case that it may be necessary to require that the change of conceptual structure have a veridical connection with the content of the message, that is, that the change corresponds to information built into the message. Nevertheless, even without a change of conceptual structure there could still be a kind of understanding of the message in the sense that the hearer could verify its truth or falsity or otherwise evaluate it. We will try to explicate some of these concepts below.

One idea that has been introduced is that of conceptual structure. Already the use of this phrase will signal that I tend to favor what may be called a cognitive account of mental activity, in contrast to the rigid behavioristic account that has been favored by some writers and that attempts to describe human behavior purely in terms of observable stimuli and responses. An early example of such an account, as applied to language behavior, is the little story that the linguist Bloomfield (1933, pp. 22-27) tells about how Jill gets Jack to fetch her an apple from a tree:

> Suppose that Jack and Jill are walking down a lane. Jill is hungry. She sees an apple in a tree. She makes a noise with her larynx, tongue, and lips. Jack vaults the fence, climbs the tree, takes the apple, brings it to Jill, and places it in her hand (Bloomfield, 1933, p. 22).

According to Bloomfield, Jill made a "linguistic substitute reaction" to her hunger and her sight of the apple in the tree which, for Jack, constituted a "linguistic substitute stimulus" that resulted in his "practical reaction," i.e., vaulting the fence and getting the apple. Bloomfield concludes that "language enables one person to make a reaction (R) when another person has the stimulus (S)" (p. 24; italics in the original). Evidently, Jack's understanding of Jill's speech (and presumably his learning from it) is indexed, according to this account, by the "practical reaction" he made that satisfied Jill. Obviously, this account is highly oversimplified; yet it is about as far as we can go if we restrict ourselves to observing overt responses. For all we know, Jack could have been responding to a pointing gesture; perhaps Jack would have fetched the apple even without a sign from Jill; maybe Jack didn't even understand Jill's language; etc., etc. Even if we examine the structure of Jill's utterance (e.g., "Jack, get me an apple in that tree!") in

terms of other utterances Jack and Jill might exchange on this or other occasions, i.e., the whole corpus of utterances in Jack and Jill's language, we might not be able to trace the connections between "practical events" and "linguistic substitute reactions (and stimuli)" that could account for the sequence of observed events. In fact, even the account which Bloomfield gave did not completely exclude certain unobservable variables--Jill's hunger, Jill's sight of an apple.

Undoubtedly, the most extensive attempt to develop a rigorous behavioristic account of language behavior is that of Skinner (1957). According to Skinner, "the listener can be said to understand a speaker if he simply behaves in an appropriate fashion. . . . In 'instruction' we shall see that he understands to the extent that his future behavior shows an appropriate change. These are all ways in which we are said to 'understand a language'; we respond according to previous exposure to certain contingencies in a verbal environment" (p. 277). Skinner goes on, however, to describe "another process" that is involved in understanding:

> Suppose we start to read a fairly difficult paper. We respond correctly to all the words it contains, so far as dictionary meanings go, and we are familiar with what is being talked about; still, we may not understand the paper. We say that we do not "get it" or do not "see what the writer is driving at" or why he says what he says. What we mean is that we do not find ourselves responding in the same way. The paper does not supplement verbal behavior in us which exists in any considerable strength. We possess each of the responses in the sense that it is part of our verbal repertoire, but we do not tend to emit it under the same circumstances as the author of the paper. This meaning of understand is in accord with the layman's use of the word. We understand anything which we ourselves say with respect to the same state of affairs. We do not understand what we do not say. We misunderstand when we say something else with the same words--that is, when we behave in a given way because of the operation of different variables.

> Suppose, now, we go over the paper again--as we must if we are ever to understand it. What processes will explain the changes which take place? Intraverbal sequences established during the first reading will, of course, leave their effect: the paper will now be familiar. To some extent, therefore, we will tend to say the same things. Through this process alone we might eventually memorize the paper. But that would not be enough; we might still say that we do not understand it, though we should probably say that we now understand it to some extent. Other processes must take place if we are to get the point the writer is making. Instruction [in a special sense] . . . will probably occur. Some sentences in the paper will present two or more verbal stimuli together in what we call definition; the resulting change in our behavior will be felt when these responses occur separately elsewhere in the text. Other sentences, through predication, will produce other transfers of response by increasing our "knowledge." Our behavior will be altered on subsequent readings in the direction of increased understanding because our usage will then be closer to the writer's (Skinner, 1957, p. 278).

A basic paradox presents itself in such a "behavioristic" account: the description inevitably involves subjective terms--terms that are inadmissible within the behavioristic framework: "we do not <u>find ourselves</u> responding in the same way" as the writer when we do not understand him. . . . When we are informed by definitions appearing in a text, "the resulting change in our behavior will be <u>felt</u> when these responses occur separately elsewhere in the text." "Our behavior will be altered on subsequent readings in the direction of increased <u>understanding</u>. . . ." (Emphasis added.) A strictly behavioristic account seems ultimately unable to deal with a person sitting quietly reading a book and making subjective responses to it, whether those responses represent understanding, misunderstanding, or hopeless lack of comprehension, for there is little chance that one could ever trace <u>all</u> the consequences of those responses in some future behavior, particularly since some of the future behavior itself would be largely unobservable.

There have been other accounts of the behavioristic type. For example, Staats (1968, pp. 511 ff.) warns against thinking that "comprehension" involves

"some ineffable 'mental' process" and claims that instead it involves the production of "new sequences of classically conditioned meaning responses" on the analogy of sensory conditioning (p. 513). Although Staats has conducted much experimental work on the production of such meaning responses, there is at present some question as to whether his results can be accounted for by a strict classical conditioning interpretation (Rozelle, 1968). In any case, the only advantage of Staats's account over Skinner's appears to be that it attempts to describe the moment-to-moment responses of the reader or hearer to language, even if they are unobservable, and refer them to constructs arising from general behavior theory. In this sense Staats's account represents a transition to a cognitive type of theory that I will now present, or perhaps to the type of "neo-behavioristic associationism" espoused by Berlyne (1965).

The cognitive view uses the data of subjective experience along with data from objective observations to construct a model of mental activity that hopefully can be refined and confirmed by further experimental investigation. It views the higher nervous system as an entity that receives, processes, transforms, and puts forth information through a series of detectable stages or cycles. Among the proponents of varieties of cognitive theory are Hebb (1949), Simon (1957), Neisser (1967), and Reitman (1965). One of the essential ideas of the cognitive view is that the information-processor contains some sort of storage of memory traces accumulated (undoubtedly with certain transformations) from previous experience; this storage contains an enormous number of <u>schemas</u>, more or less enduring patterns of brain-activity dealing with the individual's experiences of his own mind, his body, his sensations and perceptions, his environment, etc. This storage is continually being added to; as new experiences

accumulate, they tend to have the effect of transforming or modifying the already existing schemas. Somewhat on the analogy of the arithmetical processing unit of an electronic computer, the information-processing entity contains a special part that is concerned with the processing of percepts that are formed from moment to moment; some of these percepts are selected, as it were, for more or less permanent storage in memory while others may be held aside for later evaluation or even discard. At least one part of this information-processor acts as a "seat of consciousness" and processes percepts with a high-priority rating. Even though the information-processor may be thought of as consisting of separate parts, it is actually interconnected in an enormously complex way; it may act as if a number of separate sub-processors are operating simultaneously and yet in relation to each other. Large parts of the memory are more or less immediately accessible and responsive under the appropriate conditions: for example, the memory can immediately report recognition of any one of a large number of percepts that have been previously experienced and return information about these percepts (Shepard, 1967). The whole state of this information-processing entity at any given moment may be regarded as the individual's conceptual structure at that moment.

Language is the principal means of communication among the cognitive structures of different individuals. (It is not the only means, for other actions of an individual besides verbal behavior, e.g., gestures, gross motor activities, etc., can provide this intercommunication by furnishing the basis of meaningful percepts to other individuals.) Language may also play some part in intra-individual cognitive processes, such as "thinking," but it is beyond the scope of this monograph to discuss this possibility except incidentally

in connection with language comprehension processes. At any rate, the principal function of language may be said to provide a system whereby one individual can attempt to modify the conceptual structure of one or more other individuals. That is, language provides a system whereby one individual can encode certain percepts into messages that under appropriate conditions evoke representations of their percepts in the information-processing entity of another. If A reports to B, "I have a headache," this does not generally cause B to have a headache, but it does evoke the concept "headache" which is a representation of past percepts of B's own headaches.

The general model of communication and learning through language can be depicted in its gross aspects in Figure 2.1. Psychological processes in the originator of a message are represented on the left-hand side of the figure; processes in the receiver of the message on the right-hand side. Insofar as the message may have any kind of permanent form (a written document, a tape-recording, etc.) the processes in the receiver may take place at any time after those in the originator, even centuries later. Nevertheless, the originator perceives some kind of occasion to communicate: he may know that some willing hearer is present, or assume that a potential reader will receive his written message. Whatever the occasion, his percept gives rise to a process whereby selected aspects of his momentary cognitive structure are encoded into a linguistic message. From the standpoint of its function, the message has two aspects: (1) it conveys some kind of "information," and (2) it has some <u>intended</u> stimulus value. The information it conveys may be regarded as a report of certain aspects of the originator's momentary cognitive structure; such a report may include a report of gaps in the information possessed by the originator or potential gaps in the receiver's information

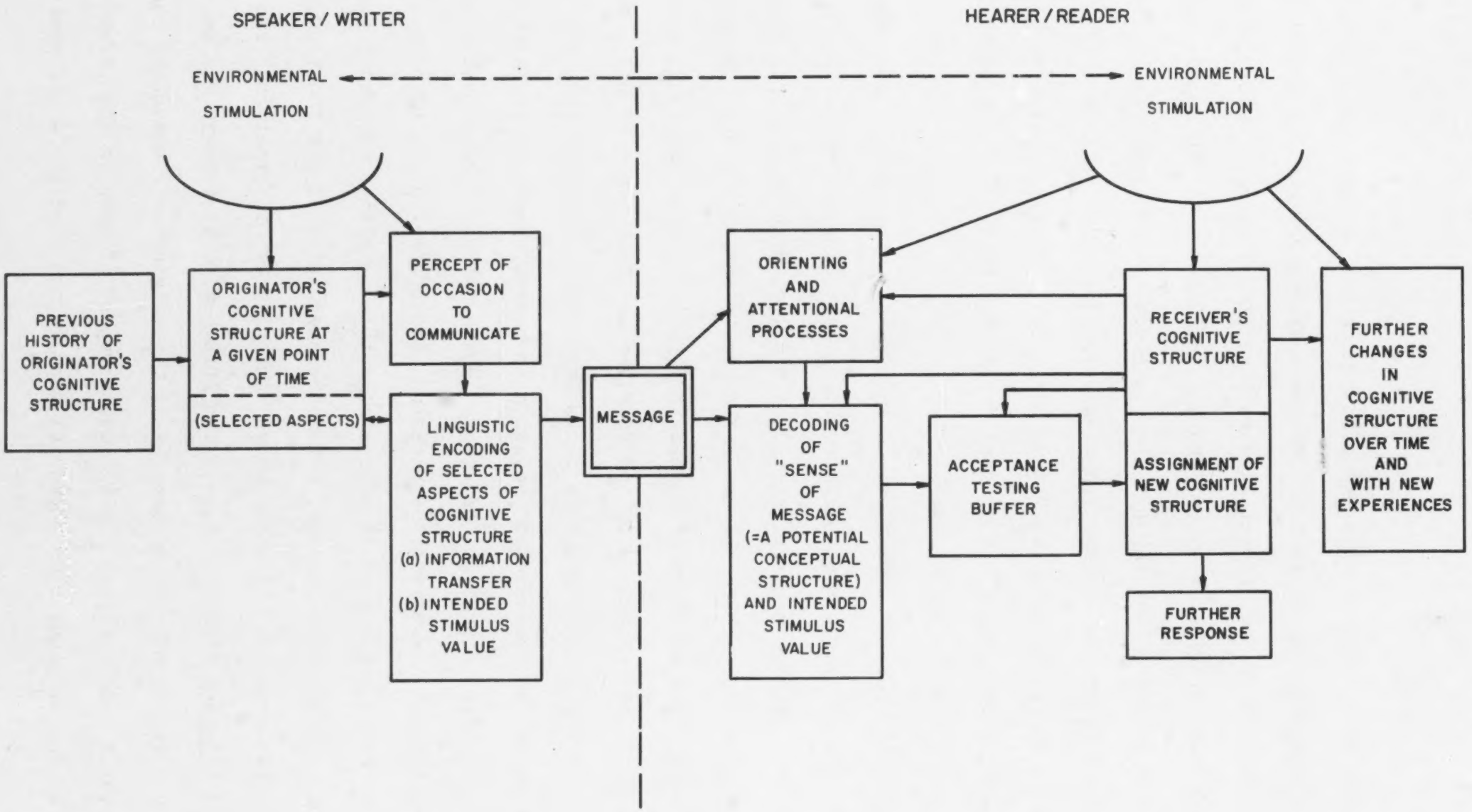

SPEAKER / WRITER
HEARER / READER
ENVIRONMENTAL STIMULATION
ENVIRONMENTAL STIMULATION
PREVIOUS HISTORY OF ORIGINATOR'S COGNITIVE STRUCTURE
ORIGINATOR'S COGNITIVE STRUCTURE AT A GIVEN POINT OF TIME
(SELECTED ASPECTS)
PERCEPT OF OCCASION TO COMMUNICATE
LINGUISTIC ENCODING OF SELECTED ASPECTS OF COGNITIVE STRUCTURE (a) INFORMATION TRANSFER (b) INTENDED STIMULUS VALUE
MESSAGE
ORIENTING AND ATTENTIONAL PROCESSES
DECODING OF "SENSE" OF MESSAGE (=A POTENTIAL CONCEPTUAL STRUCTURE) AND INTENDED STIMULUS VALUE
ACCEPTANCE TESTING BUFFER
RECEIVER'S COGNITIVE STRUCTURE
ASSIGNMENT OF NEW COGNITIVE STRUCTURE
FURTHER RESPONSE
FURTHER CHANGES IN COGNITIVE STRUCTURE OVER TIME AND WITH NEW EXPERIENCES

Figure 2.1. A general model of communication and learning through language

(as when a teacher asks a pupil a question). The intended stimulus value of the message may embrace one or more of the following:

(1) Drawing the attention of the receiver to some state of affairs represented in the originator's cognitive structure, that is, eliciting a corresponding change in the receiver's cognitive structure.

E.g., "It's five o'clock." "John came."

(2) Eliciting an affective response on the part of the receiver, whether or not a corresponding affective response is present in the originator.

"How late it is!" "Surprise!" "You're wonderful!"

(3) Eliciting a further verbal response (i.e., a "reply") from the receiver (usually indicating a gap in the originator's information)

"What time is it?" "Tell me your name." "What's 2 + 2?"

(4) Eliciting any given behavior (cognitive, affective, or motor) on the part of the receiver.

"Consider this fact." "Don't feel sorry." "Write your name here."

The information encoded in the message and its intended stimulus value affect the linguistic structure of the message, but not in any one-to-one manner. That is, a given kind of information and a given intended stimulus value may be encoded in a number of ways, e.g.,

What's your name?

Tell me your name.

I want to know your name.

all have approximately the same information and intended stimulus value (to elicit a reply containing the hearer's name).

On the receiver side, the receiver's momentary state of cognitive structure, along with environmental stimulation and/or self-stimulation, arouses orienting processes that allow him to "attend" to the message. If he knows the language, he decodes it into its linguistic elements and detects information contained in it and some intended stimulus value. This process of decoding may not be either instantaneous or accurate; in any case it is affected by the receiver's cognitive structure. The decoding process produces a potential conceptual structure. (More detailed discussion of linguistic decoding occurs below.) Once the "sense" and "intended stimulus value" of the message have been detected (whether correctly or incorrectly), these aspects are submitted to what I have called an "acceptance testing" buffer. This represents a postulated process whereby the receiver decides whether the "sense" of the message is true or false, or otherwise worthy of further attention, retention, or response. The result of this "acceptance testing" determines how the content of the message is stored in the receiver's cognitive structure, and how it may be acted upon in future behavior. The receiver may decide that the message contains important new information, in which case it may be tagged in that way as it is stored in cognitive structure. On the other hand, the receiver may decide that the information is not new, or false, or contradictory, or hypothetical; he may decide that the originator of the message was lying, or that he himself does not wish to act upon the intended stimulus value, in which case the information contained in the message will be tagged accordingly as it enters cognitive structure. The acceptance testing process is in any case affected by current cognitive

structure and indirectly by current environmental and self-stimulation. The outcome of the communication process is a change in the receiver's cognitive structure, represented in Figure 2.1 by the part of the cognitive structure box labeled "assignment of new cognitive structure." This change may be considered an instance of learning. As determined by the manner in which the new cognitive structure has been tagged, it may also result in a further response on the part of the receiver, for example, a motor response, or a verbal reply (in which case the receiver becomes now an originator). But the cognitive structure itself will undergo further changes, over time, with new experiences and particularly, with further communicative exchanges. These changes also are phenomena of learning and retention.

It will be noted that a broken line has been drawn between the environmental stimulation of the message originator and that of the message receiver. This is to represent the fact that even if the originator and the receiver live at different epochs of history, at least some features of their environment are shared. For example, ancient authors may be said to have written about certain aspects of their environments that share features in common with the environment of the present-day reader--the nature of the physical universe and certain aspects of the social environment. Communication and learning have to do with changes in people's cognitive structures with respect to their environments: in this sense communication and learning have to do with <u>meaning</u> or <u>semantics</u>.

The above description is extremely generalized and lacking in detail; it is intended merely to set the stage for further exposition of a theory of communication and comprehension.

Two Senses of "Understanding"

A theory of learning from MVD requires us to distinguish two general senses of the verb understand. As a matter of fact, these two senses are distinguishable by semantic and syntactic analysis; rules can be stated that in many cases can unambiguously assign one or the other of these senses to a given instance of the word.

Consider the following possible messages:

(1) I understood "He's coming."

(1a) I understood "Er kommt" (German)

(1b) I understood that utterance.

(1c) I understood the broadcast.

(2) I understood his coming.

(2a) I understood him.

(3) I understood he's coming.

(4) I understood German (when I was young).

(5) I understood carburetors.

It is interesting to notice, incidentally, that sentences (1), (2), and (3) differ only very slightly, yet a competent native speaker will instantly interpret the word understood in different senses, because of the semantic and syntactical status of the groups of words that follow.

Sentences (1) and (1a) clearly exemplify the sense of the verb understand whereby it means "to apprehend, on a particular occasion, a particular meaning of a message, or some presentation of a message by a person or other entity capable of originating a message." Let us designate this meaning as $understand_1$.

Sentences (3), (4) and (5) exemplify the general sense of the verb understand whereby it means "to be in a state of knowledge, competence, or cognitive feeling (e.g., sympathy) with respect to something." In sentence (3), the knowledge was attained by being informed; in (4), it was attained by some process of language acquisition; in (5) by some process of learning and experience. Let us designate this meaning as understand$_2$.

Several of the above sentences are now seen to be ambiguous.

(1b) I understood$_1$ that utterance = I understood$_1$ what it said, the plain message.

I understood$_2$ that utterance = I understood$_2$ why it was said.

(1c) I understood$_1$ the broadcast = I understood$_1$ the plain sense of the message it contained.

I understood$_2$ the broadcast = I understood$_2$ why it was made.

(2) I understood$_1$ his coming = I understood$_1$ what he intended to communicate by coming.

I understood$_2$ his coming = I understood$_2$ the reasons for his coming, the situation that prompted it, etc.

(2a) I understood$_1$ him = I understood$_1$ what he said.

I understood$_2$ him = I understood$_2$ his nature, characteristics, propensities.

Even (4) might be explicated either as "I was able to understand$_1$ sentences in German when I was young," or possibly as "I was able to understand$_2$ the nature of the German language when I was young." Actually, understand$_2$ has a number of somewhat different senses, as one can see by consulting a dictionary; the main concern here is to distinguish understand$_1$

as a special sense which can occur when the object of the verb is a message or some presentation of a message.

These two senses of understand correspond, in fact, to two distinguishable processes in understanding and learning from verbal discourse. Understanding$_1$ refers to the process of apprehending the "plain sense" and intended stimulus value of a message, while understanding$_2$ refers to the knowledge in cognitive structure that may result from learning from all kinds of experience, including verbal discourse. Although the distinction may seem obvious or trivial, it is one that has not always been properly observed in research on learning from verbal discourse. Some researchers have been concerned solely with understanding$_1$, but many have been concerned with understanding$_2$ without realizing that understanding$_1$ is often a prerequisite for understanding$_2$. Even the study of understanding$_1$ entails concern for understanding$_2$ because an individual's understanding of a message often clearly depends upon his prior state of knowledge with respect to the content of the message.

The distinction also has implications for deciding how to measure understanding and learning. In an ideal communication situation--at least, ideal for the transmission of knowledge--aspects of the originator's cognitive structure would be transmitted or exactly replicated in the receiver's cognitive structure. Thus, Einstein might have been able to communicate all his knowledge about relativity to a learner in such a way that the recipient had the same cognitive structure with respect to relativity as Einstein. Obviously this could never have happened, for there would have been information losses (and gains) at various points in the communication process. It

is doubtful that even Einstein could have encoded his cognitive structure without information loss, both because language may be an imperfect instrument for such encoding and because Einstein might not have been able to select or retrieve precisely the information that a given learner might need. Even if precisely the right information had been perfectly encoded by Einstein, it is unlikely that a given learner would have been able to decode Einstein's messages with perfect fidelity, or, once decoded, to integrate the decoded messages into his own cognitive structure without various losses and gains of information. Einstein's understanding$_2$ of relativity could not correspond exactly to the learner's understanding$_2$ of relativity, because the learner started with a different cognitive structure from Einstein's. Nevertheless, we might content ourselves with a measurement of the learner's understanding$_2$ of relativity before and after he received instruction from Einstein, to assess the effect of Einstein's messages about relativity. Even this would be difficult, for there is no sure way of measuring the contents of a person's cognitive structure. We can only probe cognitive structure by using the learner partly as a source of further messages and responses and partly as a recipient-evaluator of messages. From such probes we might be able to build up evidence from which we could make at least some inferences about the learner's understanding$_2$ of relativity.

Here is the attempt of two educators to summarize techniques of measuring understanding$_2$ on the part of learners (Findley and Scates, 1946, p. 64).

1. In every subject-matter area there are available at present many well-known procedures for the evaluation of understanding.

2. To provide evidence of understanding, evaluation situations must contain an element of novelty, but not too much novelty.

3. Understanding is of many kinds and many degrees, and evidence is to be sought on appropriate levels.

4. Procedures employed to measure understanding should provide evidence of appreciation of primary reality.

5. Since intelligent behavior in many situations involves the ability to recognize the relevancy and sufficiency of data, evidence of this ability should be sought.

6. Evidence of understanding is to be found in originality of performance on the part of pupils.

7. Evaluation procedures should be selected with due regard for the likelihood of their evoking evidence of the kind of understanding that is required.

8. In obtaining evidence of understanding, care should be exercised to insure that the pupil's response reflects his actual level of understanding.

9. The program of evaluation should be planned so as to foster the development of habits of self-appraisal on the part of pupils.

A much more limited objective is to try to measure an individual's understanding$_1$ of a message. We do not require that the learner fully accept the content of the message, or learn it in the sense of putting it in more or less permanent storage; we simply wish to find out whether he has understood$_1$ the message "as it stands." To say that an individual can understand$_1$ a message "as it stands" requires the assumption that the message itself contains a "meaning" which is derivable solely from its linguistic structure. It may appear that the bulk of messages encountered in daily life or in ordinary reading do indeed contain such meanings, and it may be that some do. Upon analysis, it will be found that not all sentences or utterances are unambiguous by themselves; they are usually disambiguated by some sort of surrounding "context" of either a verbal or non-verbal character--context that the recipient can take account of in interpreting, that is, finding a meaning of the sentence. (This may or may not be the "intended" meaning

encoded by the originator of the message.) If the recipient of a message is permitted to have enough contextual information he should be able to arrive at the one most likely "reading" or interpretation of the message. There will, however, remain a small residue of messages that are not disambiguated even by the context. Chapter 3 will survey the various methods that have been employed to measure understanding$_1$ of messages.

Theories of Sentence Comprehension (understanding$_1$)

After a long period in American linguistics during which problems of syntax were largely neglected, the theory of transformational generative grammar developed by Chomsky (1957, 1965) has come to dominate the thinking of psycholinguists concerned with processes of sentence understanding and production. While transformational generative grammar does not itself aim to explain or otherwise account for the actual behavior or performance of speakers, hearers, readers, and writers in using language, it does aim to provide an abstract model of the so-called competence of these language users. Presumably, the language user's competence plays some role in his use of language; exactly what that role may be is, in fact, the task of the psycholinguist to discover.

A brief exposition of key concepts in the theory of transformational generative grammar will be useful to the reader in understanding some of the subsequent discussion. According to Chomsky and his followers, a grammar of a language is a finite set of rules that will generate any one of a potentially infinite number of sentences that will be accepted by users of the language as "grammatical" and none of the sentences that would be rejected by language users as "ungrammatical." Hence, the theory of the grammar of a language is a theory of what the language user "knows" in order to generate

and understand grammatical sentences, that is, a theory of his "competence." The criterion of grammaticality is thus the intuition of the idealized language user--one who has absorbed in some way the rules of the language and can reflect them in his use of the language.

The formulation of transformational grammar has undergone a number of changes since first proposed by Chomsky; in fact, it is still undergoing change. In a brief statement prepared by Chomsky, the grammar of a language is characterized as

> a system of rules that determine a certain pairing of sound and meaning. It consists of a syntactic component, a semantic component and a phonological component. The syntactic component defines a certain (infinite) class of abstract objects (D, S), where D is a deep structure and S a surface structure. The deep structure contains all information relevant to semantic interpretation; the surface structure, all information relevant to phonetic interpretation. The semantic and phonological components are purely interpretive. The former assigns semantic interpretations to deep structures; the latter assigns phonetic interpretations to surface structures. Thus the grammar as a whole relates semantic and phonetic interpretations, the association being mediated by the rules of the syntactic component that define paired deep and surface structures. . . .
>
> This formulation should be regarded as an informal first approximation (Chomsky, 1967, pp. 406-407).

Later,

> . . .the linguistic evidence now available seems to point consistently to the conclusion that the syntactic component consists of rules that generate deep structures combined with rules mapping these into associated surface structures. Let us call these two systems of rules the base and the transformational components of the syntax, respectively. The base system is further divided into two parts: the categorial system and the lexicon (pp. 419-420).

As a concrete example, Chomsky takes as a base system a small subset of English consisting of a lexicon:

it, fact, John, Bill, boy, future (Nouns)

dream, see, persuade, annoy (Verbs)

sad (Adjective)

will (Modal)

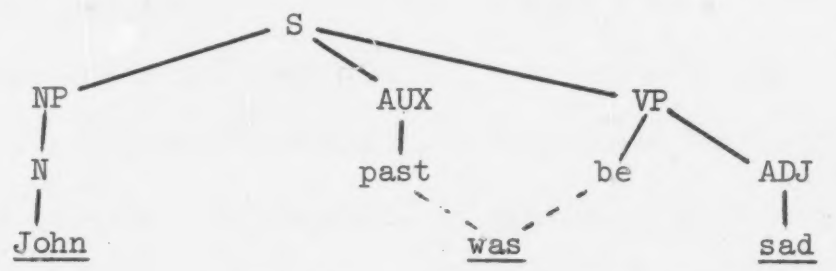
the (Determiner)

and a set of "re-write" rules in the categorial system:

S -> (Q) NP AUX VP [read: Sentence may be rewritten as (Question), Noun-Phrase, Auxiliary, Verb-Phrase]

VP -> be ADJ
VP -> V (NP) (of NP)
NP -> (DET) N (that S)
AUX -> past
AUX -> M
N, V, ADJ, DET, M -> Δ (where Δ represents any "terminal" element in a surface structure)

and proceeds to show how such sentences as John was sad and The boy will persuade John of the fact that Bill dreamt can be derived or "generated" therefrom. For example, the derivation of John was sad can be represented by a "tree diagram" as follows:



(The formative was is derived from past be by a supplementary transformational rule.)

A tree diagram thus represents the relation between the "deep" and the "surface" structures of the sentence. It also represents the information required for semantic interpretation of the sentence. For Chomsky, "competence" involves the ability (implicitly) to assign "structural descriptions" to sentences.

A famous example may make this clearer.

(1) John is eager to please.

(2) John is easy to please.

Although these sentences appear to have similar "surface" structure, their "deep structures" are different, as shown by the fact that we can convert (2) into another form:

(2a) To please John is easy

but we cannot similarly convert (1) to *To please John is eager without destroying the meaning. If we follow Chomsky's doctrine, the "base structure" of (1) derives John from a noun phrase that is subject of a verb phrase is eager to please, while the base structure of (2) derives John from a NP that is the object of a verb to please in a deep-structure verb phrase (To please John is easy). According to Chomsky our "internalized grammar" is automatically cognizant of these grammatical relationships.

In order to make possible such recognition, of course, "competence" must include a sort of "dictionary" in which the possible lexical and grammatical features of the formative elements (words, affixes, etc.) of the language can be looked up and retrieved. It must also contain some representation of the rules by which base structures are realized in surface structures--not, to be sure, a completely conscious knowledge of these rules. Chomsky and his followers are silent as to the actual psychological status of these rules; this is an issue that is regarded as outside the province of linguistics. Chomsky's object is simply to formulate the grammar (including syntactic, semantic, and phonological components) in such a way that it will most parsimoniously achieve the object of being able to generate (or assign

structural descriptions to) all the grammatical sentences of the language and none of the ungrammatical ones.

Chomsky's transformational generative grammar has given rise to a truly enormous literature in linguistics--including applications of the theory to special problems in the grammar of English and many other languages, further developments of theory (e.g., Katz and Postal, 1964), and critical discussions (see the bibliography by Dingwall, 1965).

Chomsky's discussions of the distinction between "competence" and "performance" have implications for the field of psycholinguistics. "A generative grammar," he says "is not a model for a speaker or a hearer. It attempts to characterize in the most neutral possible terms the knowledge of the language that provides the basis for actual use of language by a speaker-hearer. . . .When we say that a sentence has a certain derivation with respect to a particular generative grammar, we say nothing about how the speaker or hearer might proceed, in some practical or efficient way, to construct such a derivation. These questions belong to the theory of language use--the theory of performance" (Chomsky, 1965, p. 9). In brief remarks "towards a theory of performance" he carefully distinguishes between "grammaticality" and "acceptability," the former a property of sentences formed by a grammar, the latter a property of sentences that are "perfectly natural and immediately comprehensible without paper-and-pencil analysis, and in no way bizarre or outlandish." He suggests that profitable studies of acceptability might consider the role of certain grammatical phenomena, such as nested, self-embedded, multiple-branching, left-branching, or right-branching constructions. (As will be seen in this monograph, many studies of these phenomena have now been performed.)

During the early years of the 1960's, a popular research problem among psychologists was the attempt to demonstrate the "psychological reality" of various grammatical phenomena, in particular, certain "transformation rules" such as passivization, negation, and question-formation. Unfortunately, although this work seemed to produce interesting results, its basis has now come under much questioning, partly because of modifications of transformational theory and partly because of flaws in experimental procedure and design. This monograph will review, in Chapter 4, the present status of some of this work.

For current opinion on the theory of performance, I draw on the report of a conference held in Edinburgh, March 1966 (Lyons and Wales, 1966). I emphasize those aspects of the discussion that relate to the understanding of language. Of particular relevance here are papers by Thorne, by Wales and Marshall, and by Fodor and Garrett. I will try to summarize the discussion in terms of a number of major issues.

1. What is the nature of a theory of competence? From the standpoint of the linguist, a theory of competence is essentially an axiomatization of the rules of a language, similar to an axiomatization of the rules of the number system. As such, it is an abstraction. In saying that the rules of a language "generate" sentences, the linguist uses the term generate in a purely formal sense: this phraseology makes no statement as to whether in the normal use of language individuals generate sentences according to such rules. Nevertheless, it can be pointed out that a theory of competence is "psychological" at least in one sense: that it "purports to be a principled account of the linguistic knowledge of human beings rather than a totally ad hoc description of the language" (Wales and Marshall, 1966, p. 29). Chomsky has distinguished two

levels of descriptive adequacy of grammars: (1) WEAK "descriptive" power--whether all and only the possible terminal strings of a language are generated; and (2) STRONG generative or "explanatory" power--whether the structure assigned to these strings describes correctly how the idealized native speaker would understand these strings. Particularly in the evaluation of grammars as to their STRONG generative power, then, it would seem that a theory of competence involves statements about language use, i.e., the understanding of sentences. It seems clear, then, that there is at least a very intimate and perhaps inextricable relationship between a theory of competence and any theory of performance. It is agreed, in any case, that a theory of performance must presume an adequate competence model, i.e., an adequate axiomatization of the language. Experiments concerning speaker-hearer performance must be designed and interpreted in the light of such a model.

[It may be noted that Schwarcz (1967) has protested against the assumption that there can be an "idealized speaker-hearer" whose competence is formalized, because such a concept is a fiction. He suggests that this concept be replaced by that of the "typical speaker-hearer"--"a set of basic mechanisms for understanding, using, and learning language, plus a memory structure for the storage of both linguistic and nonlinguistic facts." In essence, Schwarcz rejects a theory of competence unless it is subsumed under a theory of performance.]

2. <u>What would a satisfactory "theory of performance" be</u>? A preliminary definition is given by Wales and Marshall (1966, p. 30): "It is a theory of how, given a certain linguistic competence, we actually put it to use--realize

it, express it. It is also a theory of the limitations of the mechanisms, which enable us to express our linguistic competence. . . . We want to be able to explain NORMAL performance--when the translation from competence to performance is proceeding smoothly--just as much as we want to explain errors and deviations." As a theory, a theory of performance may be as much an abstraction as a theory of competence, but the abstract quality of any theory is precisely what gives it its generalizing power. A theory of performance might, according to Wales and Marshall, consist of two parts: a part concerned with the general type of system that makes competence and performance possible, and a part concerned with the specific mechanisms involved. The task of the psycholinguist is to discover these mechanisms. The theory might include an algorithm that would describe the manner in which the individual processes information either in sentence production or in sentence understanding. (A tentative algorithm has, for example, been proposed by Dewar, Bratley, and Thorne (1969) which reasonably simulates certain aspects of sentence understanding.)

3. Is it profitable at this stage to develop models or schemas of linguistic performance? Wales and Marshall (1966, p. 55) propose such a schema, reproduced in Figure 2.2. They do not claim it to be a MODEL, however, offering it only as serving to indicate the hypothesized order of processing linguistic information and to suggest points for study. For sentence understanding, it is to be read from the bottom up; for sentence production, from the top down. It assumes that the basic unit of linguistic performance is the sentence, rather than the word; that the analysis of sentences is continuous, rather than operating on input strings in temporary stores; and

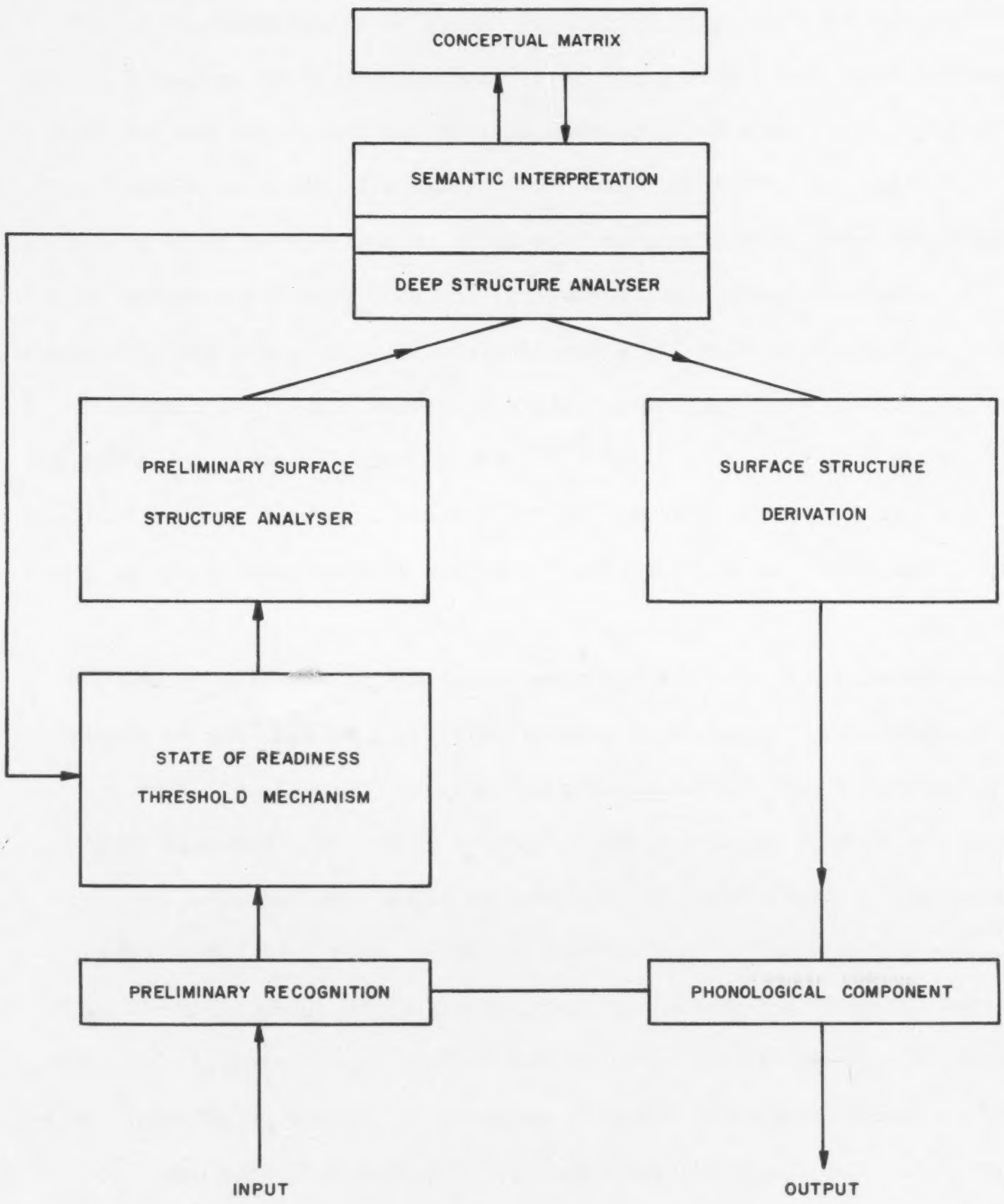


Figure 2.2. A schema of linguistic performance (Wales & Marshall, 1966)

that "at any given time, the process operates only uni-directionally--that is, recognition and production procedures cannot be simultaneous." (It may be commented that this last assumption is counter-intuitive; certainly during sentence production there are processes whereby one recognizes the sentence being produced.) Nevertheless, Blumenthal comments in the same volume (p. 84) that Wales and Marshall's schema is "too lofty an abstraction to be of heuristic value" in suggesting techniques, mnemonics, and cues that the language user employs. He also feels that it is counter-intuitive in suggesting that input processing proceeds from surface-structure to deep-structure to semantic interpretation. In this very comment Blumenthal demonstrates the usefulness of such schemas in raising issues. My own recommendation is that we continue to propose and test schemas of this sort, making them as complicated as the data warrant.

For comparison, a considerably more complicated schema (or "model") of sentence construction proposed by Danks (1969b), Figure 2.3, may be examined. Danks is concerned with the processing not only of "normal" well-formed sentences but also of various kinds of deviant sentences. For this purpose he introduced "Ziffian" rules (Ziff, 1964) to allow the individual to find the most probable path to a well-formed sentence. Notice also that Danks introduces "context" as additional input, and that the output is an "idea." Presumably this "idea" is what gets stored in Wales and Marshall's "conceptual matrix." A somewhat similar schema is proposed by Schwarcz (1967) in a pair of "flowcharts" for linguistic performance. Figure 2.4a is analogous to Danks' schema for sentence processing, showing the output as a "conceptual structure." In Figure 2.4b this conceptual structure is taken as input for

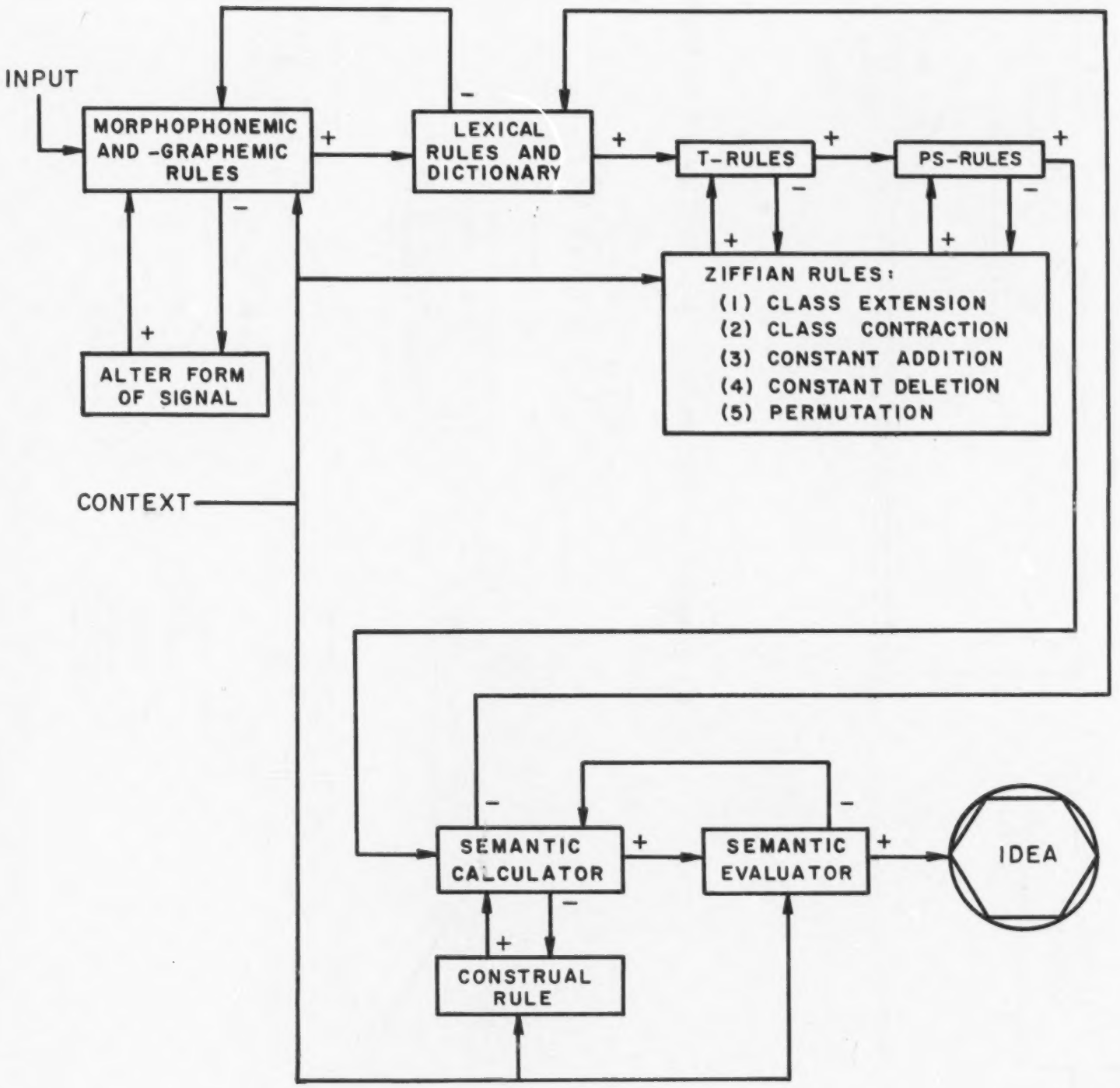
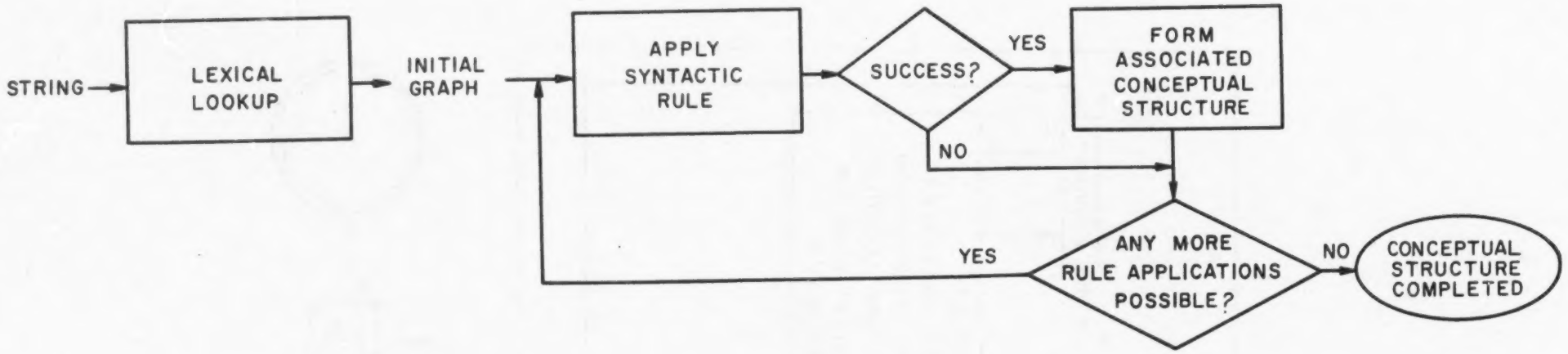


Figure 2.3. A schema of sentence comprehension (Danks, 1969b)

(a) SEMANTIC INTERPRETATION OF AN UTTERANCE



(b) CONCEPTUAL RESPONSE TO A SEMANTICALLY INTERPRETED UTTERANCE

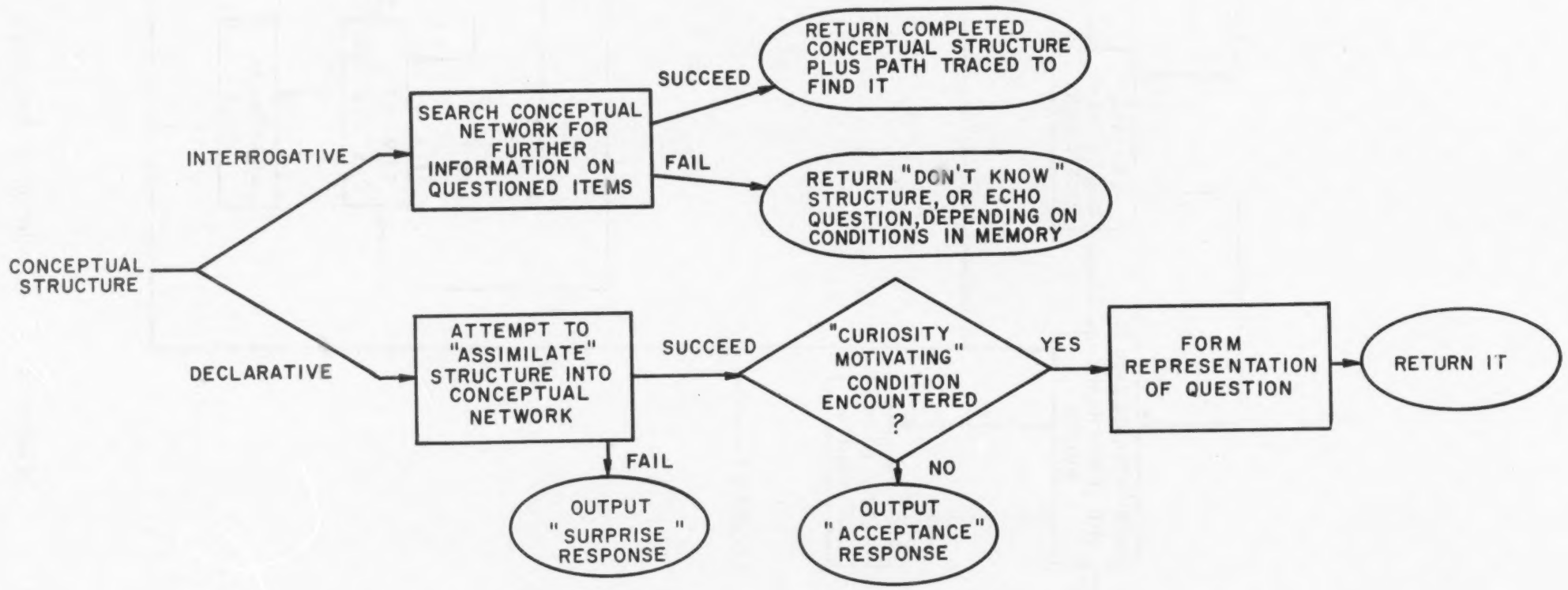


Figure 2.4. Further schemas of sentence comprehension (Schwarcz, 1967)

further processing depending upon whether the sentence is interrogative or declarative, and depending upon whether the information in the sentence arouses a "curiosity motivating condition." Thus, Schwarcz introduces a feature somewhat similar to the "acceptance testing buffer" I have postulated in Figure 2.1.

Even without schematic diagrams, it is possible to speculate about some of the detailed processes in sentence understanding. A spoken sentence input to the hearer inevitably comes in a temporal sequence from "left to right" but there is obviously some possibility for "re-scanning" material already heard and stored in temporary short-term memory. Printed sentences are normally read from left-to-right (leaving aside the reading methods advocated by some "speed reading" courses), but there is much more opportunity for rescanning. In any event, there is room for investigation of how the hearer/reader is able to perceive or "compute" deep structure from surface structure. Does he build a tree diagram "from left to right" and from "top to bottom," or the reverse? Does sentence processing proceed in any such straightforward fashion at all, in either direction? Various superficially plausible models for sentence processing have been proposed by such theorists as Johnson (1965), Osgood (1963), and Yngve (1960), but the present consensus seems to be that none of these models are even approximately correct. It seems best, for the time being, to wait for further theorizing and experimental data before fixing upon a detailed model.

One type of model that seems particularly objectionable is the "analysis-by-synthesis" model originally proposed by Matthews (1962) whereby the sentence processor generates multiple possible "synthesized" sentences from the input and then selects the sentence structure that matches the input. Fodor and Garrett (1966, pp. 139-141) show formally that such a device could not possibly operate in real-time because of the enormous number of searches and matchings that would be involved.

4. Is it necessary for the hearer to arrive at a "full structural description" of a sentence in order to understand it? By a "full structural description" is meant an assignment, by the hearer/reader, of each word or other linguistic element to some position in the grammatical structure of the sentence--e.g., that a certain phrase is the subject of the sentence, that a certain word or phrase modifies it, that a certain part of the sentence is the predicate, that a certain adverb (e.g., probably) modifies the whole of the rest of the sentence, etc. (There is a further question, with which I will not deal here, as to whether the "full structural description" involves perceiving the "deep structure"; for example, in hearing the sentence The boy was hit by the ball does the hearer have to recognize that this is a transformation of a sentence The ball hit the boy? Obviously, the hearer must recognize that the causal agent was the ball, not the boy, but the question becomes one of whether sentence perception actually involves recognizing a transformation.)

Fodor and Garrett (1966, p. 142) give a most confident affirmative to the question raised above: "That it is the full structural description of a sentence which is the psychologically pertinent output of a recognition device is not now open to serious doubt. It is only in terms of the relations the structural description marks that such intuitively-available notions as grammaticality and syntactic ambiguity can be reconstructed, and only by reference to these relations that a general characterization of syntactic similarity between sentences can be formulated. To put it slightly differently: the structural descriptions assigned by generative grammars automatically provide formal counterparts for grammatical relations, the recognition of which lies within the perceptual capacity of speakers. This fact

can be explained only if we assume that the perceptual recognition of sentences involves the recovery of their structural descriptions." Two discussants, however, are not convinced: "Just as the logician makes use of heuristic devices in proving theorems, so it seems to me certain that the human brain must do so in recognizing and producing sentences. It does not seem to me to have been proven that all sentences must be completely decomposed into their deep structure in order to be uttered or understood. It seems possible that performance may be controlled more by a system of analogies than by a more rigorous generative procedure in which the axioms of linguistics are directly represented in the brain" (Sutherland, 1966, p. 161). This idea is exemplified by reference to producing utterances: "For example, if the brain can categorize words into types, new sentences could be formed not by directly looking up a very general rule but by looking up an instance of the use of a word of a similar type," but an analogous argument might be made for speech understanding.

Another discussant: ". . . I really cannot see why the mechanism of a hearer's understanding need be supposed to produce a full structural description for each wave-form understood; it does not seem even to have to produce all the transformation-markers (e.g., semantically redundant displacement markers, as in phone up → phone. . .up, can be omitted), let alone the phrase-markers" (Cohen, 1966, p. 169). Cohen goes on to state that producing a full description would be "an extraordinarily uneconomical procedure," considering the vast number of messages we are exposed to. He proposes that we "look for the most economical means of storing information for the purpose of showing that we do understand it."

The issue that is joined here seems to be marked with confusion as to the contexts in which sentences are understood. Clearly, Fodor and Garrett are correct in insisting that understanding implies a full structural description when the hearer/reader attends carefully to every word of an utterance; the fact that even the omission or misplacement of a word is likely to be detected under such circumstances suggests that the hearer/reader apprehends the "full structural description." Even in carefully attending to a message composed in telegraphic style, as a headline, the reader infers a structural description that specifies every significant relation among the words of the message. Now, Cohen seems to be speaking of conditions when the hearer/reader does not attend to every word--as through momentary lapses of attention or in rapid scanning of a text. Under these conditions, it is probable that the hearer/reader still infers something like a full structural description of the material he attends to, filling in certain gaps from his previous knowledge or by purely logical processes that are a function of the redundancy of the message. I conclude that Fodor and Garrett are correct, in principle, but that Cohen has introduced the important idea that complete or nearly complete structural descriptions can be produced on the basis of limited information. There is no guarantee, of course, that such structural descriptions will be as correct as they are likely to be if the full text is attended to. An interesting research problem would be to study the structural descriptions attainable on the basis of limited information, e.g., in responding to "telegraphic speech" or randomly scrambled words.

In the course of his discussion, Cohen introduces a seemingly plausible model for speech understanding that may be worth investigating. He finds this model consistent with a wide range of experimental data:

So the hearer's mechanism I am proposing is one that will map wave-forms on to memory-storage instructions. Such a mechanism must be capable of recognizing occurrences of those morphemes and combinations of morphemes (i.e., nouns, verbs, adjectives, etc.) that constitute categories under which information is usefully stored alongside established relevant rules for identification, individuation, inference, and so on; and it must be capable of distinguishing those morphemes from morphemes that are not of this kind (i.e., articles, conjunctions, etc.). It must also be capable of reversing certain transformations that have taken place in the generation of the utterance, in order to identify the appropriate filing categories (e.g., reversing displacements, like George put his own friends up from George put up his own friends), and breaking down logically compound sentences into their constituent kernels plus the relations between these. It must be capable of filing under each appropriate category a morphophonemic description of the kernel sentence or sentences plus transformation-markers which CAN be processed for a full structural description if the hearer needs to show, or utilize, his understanding in a way that requires this processing. And the hearer's mechanism must also be capable of treating its description of the wave-form as a cross-reference to other filings of the same wave-form, and of filing alongside this description a description of certain contextual circumstances of the wave-form's utterance (in order to identify the denotations of personal pronouns, demonstratives, etc., and to assist in residual disambiguation; I assume that in most cases contextual circumstances will have determined the initial filing of polysemes).

> . . . In short, what I am suggesting is that for a hearer to understand a speaker's utterances correctly is to file a partial description of it under the same memory-storage categories, and to be prepared to take to at least some extent the same linguistic and non-linguistic action on it, as the speaker would be prepared to take if the roles were reversed. To misunderstand is to file under different categories, or to file a misdescription of it; and to fail to understand it is not to file it at all, or not to file a description of it that is adequate for the purposes of eliciting implications, answering questions, checking truth-values, and so on (Cohen, 1966, pp. 169-170).

5. What is the difference between recall of a sentence and understanding it? Obviously, purely on the basis of immediate memory span a string of words (provided it is not too long) can be recalled without understanding it. A large proportion of the experiments that have been done on sentence processing have not required true understanding of the sentence; they have required

only "learning" and recall. Blumenthal (1966, p. 83) suggests that understanding is not necessary for memory; it only makes a sentence easier to remember. The criterion of "understanding" still stands as the recovery of the underlying grammatical structure, as well as the accompanying semantic information. To the extent that words perceived without syntactic structure convey semantic information, some of this semantic information may be recovered in "pure recall" and certain syntactic constructions imposed on this information in the process of recall. This would be a case of "pseudo-understanding" since the constructed syntactic information might in fact be incorrect. It may be found quite difficult to separate understanding from recall in experimental work. The most successful procedure appears to involve making the subject's task one in which he must submit the sentence input to some verification procedure with reference to a non-linguistic stimulus--e.g., a picture. (Chapter 3 will discuss this matter more fully.)

If the sentence presented is understood in the sense defined here, an interesting question has to do with what, precisely, is recalled at some later point in time. An experiment by Mehler (1963) suggests that the base structure and the transformational rules converting to surface structure are remembered separately, the base structure being generally remembered longer and better. (Later, we shall adduce more evidence for this sort of finding, with the suggestion that actually something deeper even than base structure--some non-linguistically coded "meaning"--is remembered longest.)

6. What grammatical variables influence sentence processing? A large literature on this topic is now available. Among the major conclusions which seem reasonably well established are the following:

a. Hearer/readers tend to process sentences in terms of their constituents. For example, Anglin and Miller (1968) found that sentences were more easily learned when their words are grouped according to syntactic constituents rather than otherwise: "The boy found it/in the woods" would be more easily learned than "The boy found/it in the woods." A number of experiments have shown that in a dichotic listening situation where a sentence is heard in one ear and a click is heard at a certain point of time in the other ear, the subjective placement of the click tends to be displaced towards boundaries of syntactic constituents. Schlesinger (1966b) found that the eye-voice-span tends to extend to the end of a possible constituent chain.

b. Certain aspects of deep structure, particularly the logical subject of a sentence, influence recall and understanding more than elements of surface structure. Blumenthal (1967) found that the logical subject was a more efficient prompt than the nonagent phrase in remembering sentences such as The gloves were made by tailors vs. The gloves were made by hand.

c. Some failures of understanding are due to incomplete analysis of the input. For example, interpreting The boy was hit by the girl as equivalent to The boy hit the girl can occur when the subject is under pressure (Slobin, 1963).

d. Sentences with self-embeddings are harder to understand or remember than their right-branching equivalents. Representative materials were studied by Miller and Isard (1964): A sentence with no embeddings (She liked the man that visited the jeweler that made the ring that won the prize that was given at the fair) is more easily processed and learned than one with 3 embeddings (The ring that the jeweler that the man that she liked visited made won the prize that was given at the fair).

e. Syntactic complexity as measured by number of transformations in the derivation of surface structure from base structure is, however, not always a sure guide to ease of sentence processing. Results of a number of early experiments on such transformations as passive, question, and negation were flawed by confounding of these variables with sentence length, meaning, etc., in the opinion of Fodor and Garrett (1966).

f. Violations of semantic selection rules in "semi-sentences" result in poorer sentence processing. For example, an anomalous sentence such as "Pink accidents cause sleeping storms" is less well remembered than a "normal" sentence such as "Pink bouquets emit fragrant odors" (Marks and Miller, 1964). It may be said, however, that "semi-sentences" introduce a type of semantic complexity or distortion that is not merely a matter of violating selection rules. Semantic complexity is also introduced by negation (Wason, 1961), unless the negation is used merely to emphasize that a fact is contrary to expectation (Wason, 1965).

Many of the above conclusions will be examined more closely, and the evidence updated, in later chapters of this monograph. A number of remarks seem appropriate here, however, as comments on the motivation and presuppositions of the research on sentence processing reviewed in the various chapters of the symposium edited by Lyons and Wales (1966):

Obviously the motivation for this research is to gain data for making inferences about the processes or mechanisms in the understanding of sentences. Incidentally, some of it may provide insight into the nature of linguistic competence, but if linguistic competence is simply the speaker/hearer's knowledge of his language, and if that competence can be represented as a formal axiomatic system

that can be verified independently of psychological experiments, we can expect such experiments to throw little light on linguistic systems. Our main expectation from psychological experimentation that has been reviewed here is that it will enable us to construct and refine a theory of linguistic performance.

In the experimental settings that have been employed, there is admittedly a good deal of artificiality necessary in order to permit adequate control of variables that might otherwise affect the results. Some elements of this artificiality are:

i) Typically, the subjects are normal, reasonably well educated native speakers of English. Few experiments on processes of sentence understanding have been conducted with children, aphasics, schizophrenics, or other special populations. (This is not to deny that there is a large literature on the language of children, aphasics, etc.; the point is that little of this literature contains experiments on processes of sentence understanding.)

ii) Typically, the sentences presented to the subjects are quite ordinary sentences using high- and medium-frequency words; they are presented as self-contained, isolated sentences; if a number of sentences are presented, they are unrelated in content. (A few experiments present "deviant" sentences of various kinds, but again, these are presented in isolation and they usually contain relatively familiar words or construction.) The content of the sentences is very ordinary. They are only "hypothetically" informative; a subject in an experiment is very unlikely to want to add to his permanent memory store the content of a sentence like "The boy hit the colored ball"; it would be only by an exercise of imagination that the subject could conceive a situation where such a sentence would be truly informative.

iii) Sentences are ordinarily presented in the absence of any context with which they might otherwise be accompanied. The subject has to learn a sentence

like "The boy hit the colorful ball" without being informed what boy and what ball are being spoken of. Exceptions to this observation are provided by a few experiments that employ pictorial context as referents for sentences that are to be verified. Also, a few experiments exemplify the use of materials that are inherently meaningful without context, such as true or false sentences about the number system ("Five is smaller than two"; "Five is an odd number"; "Five precedes thirteen").

iv) Sentences are presented for immediate understanding or immediate recall, only very rarely for recognition or recall after a considerable time-period.

v) Motivation of subjects is typically high, at the level one would expect in an experiment where subjects are paid volunteers who are alert and eager to please the experimenter.

One wonders whether the results of experiments conducted under such artificial conditions will easily generalize to "real-life" situations involving other than the normal, educated speaker/hearers who are the subjects in these experiments, and involving meaningful verbal discourse that consists of multiple, connected sentences with ample contextual determination. Even if we consider only single sentences, it is conceivable that in "real life" with appropriate context a complex self-embedded sentence like The race that the car that I sold won was held last summer (adapted from an example given by Miller, 1962b, p. 755) would be much more easily understood than it would in a psychological experiment. (See also Freedle and Craun, 1970.)

On the other hand, in principle everything we would want to know about sentence understanding could arise from the study of single sentences, because since single sentences are according to transformational grammar (and "common sense") infinitely expandable by recursive rules, a single sentence can

itself contain all the contextual information necessary for its understanding. Whether this principle can be sustained in a report that is concerned with the role of meaningful verbal discourse in audio-visual educational media (with their paraphernalia of non-verbal presentations) is left to the judgment of the reader.

Comprehension vs. Inference

The kind of "sentence comprehension" that has been discussed up to now involves "assigning stuctural descriptions" to the elements of the sentence. It involves also understanding the "meanings" of the separate components, including rare or technical words such as ferrule, soffit, or transducer, if they happen to occur in the sentence. Comprehension of a longer discourse such as a paragraph or an essay would involve not only these processes but also identifying the persons, things, ideas, etc. that are referred to one or more times throughout the text, even though in different words, and following the development of more complex ideas. We have been, in short, discussing "comprehension" as understanding the "plain sense" of a message.

"Comprehension" is, however, often used in a much looser sense to include both $\underline{\text{understanding}}_1$ and $\underline{\text{understanding}}_2$ as they were defined in an earlier part of this chapter. An examination of a test of "reading comprehension" or of "listening comprehension" will usually show that the test is designed so that the individual's score will reflect not only his ability to understand the "plain sense" of the material but also his ability to make inferences, i.e., to create new information that is implied by the plain sense of the message.

Various instances of simple inference can be given. Consider the sentence John is taller than Mary, and Dick is shorter than Mary. It is

conceivable that understanding the "plain sense" of this sentence would not include the inference that Dick is shorter than John; the relations between John and Mary, and between Dick and Mary, might be "understood" without the further understanding of the relation between John and Dick.

Inference is also involved in syllogistic reasoning: All A are B; All B are C; Therefore all A are C. Consider the following paragraph, used by Frase (1969c) in an experiment on paragraph reading:

> The Fundalas are outcasts from other tribes in Central Ugala. It is the custom in this country to get rid of certain types of people. The hill people of Central Ugala are farmers. The upper highlands provide excellent soil for cultivation. The farmers of this country are peace loving, which is reflected in their art work. The outcasts of Central Ugala are all hill people. There are about fifteen different tribes in this area.

This paragraph contains enough information for a subject to infer that the Fundalas are peace-loving, even though this is not explicitly stated.

Our survey of processes involved in understanding of text must take account of inferential processes as well, since what is learned from a text may include the outcomes of such reasoning processes. To attempt to draw conclusions on the nature of inferential processes would, however, take us far beyond the scope of this survey.

Chapter 3

THE MEASUREMENT OF COMPREHENSION AND LEARNING

The Problem

If the analysis in the previous chapter is correct, the act of comprehending a sample of verbal material (a "message") consists, at least initially, of deriving a "meaning" or "semantic interpretation" for it. Once the receiver of the message has derived this semantic interpretation, he may evaluate it for its "acceptability" to him (in terms, for example, of truth, relevance, or conformity to expectation), and if it is "acceptable" he may assimilate it to his cognitive structure, in which case we may say that he has "learned" the content of the message. In addition, he may derive further cognitive structure from the text on the basis of inferential processes, but because of the complexity of these processes, we shall give them little attention.

Thus, we pose for ourselves two problems in this chapter:

(1) How can any outside observer of the communication sequence determine whether comprehension has actually occurred? More specifically, how can an observer determine how much has been comprehended, and how accurately it has been comprehended?

(2) How can an outside observer determine what an individual has "learned" as the result of his receiving a message? How can one determine how the individual's "cognitive structure" has changed?

These two problems are very difficult. They are difficult to separate operationally, because any procedure for testing the degree to which an individual comprehends a message tends to involve operations that also test learning. Furthermore, both of these problems present an inherent difficulty that arises from the fact that the processes one is interested in measuring are internal and not directly observable; we can infer their nature only

from observations of overt behavior that accompanies the internal processes, either spontaneously or as the result of special arrangements that can be made, such as giving the individual prior instructions as to how he is to respond.

It should be noted that our concern here is primarily with how we can measure comprehension or learning in a specific instance where a verbal stimulus has been presented, as opposed to the measurement of comprehension or learning ability. An ability is a generalized property of the individual expressed in terms of the probability that he would comprehend or learn the meaning of any given message; one would infer an individual's ability from his performance in some systematic sample of test situations in which messages are presented to him for comprehension or learning. The problems of measuring comprehension or learning in specific instances also apply to the measurement of comprehension or learning ability, but in ability measurement many of these problems can be circumvented by statistical averaging processes. For example, comprehension ability can be measured by presenting the individual with a series of sentences to evaluate for truth or falsity; even though the chance of getting any one sentence correct by "guessing" is .5, with a large enough sample of sentences one could nevertheless obtain a reliable measure. This procedure--of having subjects evaluate sentences for truth or falsity--would be a highly unreliable one, however, for indexing the comprehension of any one of the sentences.

The main body of this chapter will be devoted to an examination of the various methods that have been proposed for the measurement of comprehension (understanding$_1$ as specified in Chapter II); it will end with some remarks on the measurement of learning.

Desiderata for Measurements of Comprehension

There are many kinds of procedures for measuring comprehension; we shall evaluate them with respect to the desiderata specified below. It would be comfortable to think that one could find one procedure that would meet all specifications, but apparently there is no such procedure. Procedures have to be selected and tailored to meet the requirements of given situations.

(1) Validity. Ideally, a measure of comprehension should reflect solely comprehension (the derivation of a correct syntactical and semantic interpretation) and not any other behavioral process such as memory, guessing, or the like.

(2) Reliability. Ideally, a measure of comprehension should be reliable in the sense that it gives consistent outcomes on equivalent trials for a given individual. Unfortunately, it is difficult to imagine that in this context there can be truly equivalent trials, because the individual is likely to be changed as a result of even one exposure of the stimulus. Perhaps for this reason, there have been few instances where the reliability of an outcome has been investigated. (However, reliabilities of tests of comprehension ability have been routinely reported.)

(3) Generality. Ideally, a procedure for measuring comprehension should be applicable to (a) all types of verbal material, and (b) all classes of individuals. By "all types of verbal material," we have in mind variation in the quantity and complexity of the material--whether it be a single word, a single sentence, a paragraph, or a longer discourse and whether it be picturable or non-picturable, concrete or abstract, literary or scientific in subject-matter, etc. By "all classes of individuals" we have in mind children, adults, native vs. non-native speakers of the language, etc.

(4) Convenience and practicality. These aspects can be broken down into:

(a) ease in preparing the measurement device;

(b) ease in administering the procedure to the individual; and

(c) ease in scoring or otherwise evaluating the outcomes in a valid and reliable way.

MAJOR TYPES OF PROCEDURES FOR MEASURING COMPREHENSION

1.0 Subjective evaluations of comprehension. Probably the simplest and most obvious procedure for determining comprehension is to ask the individual whether he comprehends. The validity of such a procedure clearly depends upon the honesty of the individual and his overall comprehension ability. Even if he is honest, he may report comprehension when he actually misperceives the meaning of the stimulus. Nevertheless, he is unlikely to report lack of comprehension when he actually comprehends. Under certain circumstances, this method may have considerable merit. Several specific procedures that have been investigated are as follows:

1.1 Subjective evaluations of comprehension, accompanied by a latency measure. Danks (1969b) presented his subjects with a series of word-strings varying in grammaticality and semantic abnormality. Samples: Colored pictures please sick children (grammatical and meaningful); Families happy neighbors pleasant make (meaningful but not grammatical); Wise parties create early flowers (grammatical but not meaningful); Active reach strange captains fines (neither grammatical nor meaningful). The subject was asked to press a button as soon as he "understood" the string, and the latency of this response was measured. The subjects were kept "honest" because they knew that every so often they might be asked to paraphrase the meaning they had apprehended. The

validity of the procedure is upheld by the fact that the latencies showed strong relationships to the meaningfulness of the sentences: the "non-meaningful" sentences took much longer to "understand." (Grammaticalness, however, was not as well reflected by the latencies.)

This procedure could not, of course, be used very generally. Danks worked with intelligent university students, all of whom could doubtless understand without any difficulty the simple "meaningful" sentences that were included in the stimulus sets. It is doubtful that this method would give valid and reliable results in evaluating individuals' comprehension of meaningful, normal text of a high level of difficulty, especially when the subjects are of limited education or verbal ability. On the other hand, this method somewhat resembles Kershner's (1964) method of testing comprehension by measuring reading time, on the assumption that the subject will complete his reading only when he thinks he understands the material.

1.2 Subjective evaluations of grammaticalness. Maclay and Sleator (1960), Coleman (1965b), Danks and Lewis (1970), Quirk and Svartvik (1966), and Tikofsky and Reiff (1967) have had subjects evaluate sentences for "grammaticalness" or "grammaticality." The sentences represent various degrees of deviance from normal English grammatical usage or patterning, and the evaluations have been made either by rating scale responses, ranking, or the like. It is found that in general subjects do indeed give ratings of grammaticalness in line with the degree to which the sentences conform to standard patterns, or are "well-formed" according to a grammar. It is beyond the scope of this review, however, to discuss the results in detail; the interest of this research is not in testing comprehension of sentences in response to grammatical patterns

but in testing the degree to which one can predict the ratings by various systems of formal grammatical rules. It is debatable whether this procedure is adequate even for the latter purpose, in that "acceptability" in a communicative sense may not correspond very well to "grammaticality" in the sense of conformity to a given set of grammatical rules. In any case, the method does not yield valid measurements of comprehension since it is addressed principally to grammaticality, which according to Danks' (1969b) results can be orthogonal to meaningfulness or comprehensibility.

1.3 Subjective evaluations of comprehensibility. Danks (1969b) presented a series of sentences varying in grammaticality and meaningfulness to university subjects, asking them to rate them for "comprehensibility," no explicit definition of comprehensibility being given. By statistical techniques, it was found that 95% of the variability in the ratings could be explained by three orthogonal factors: grammaticalness, meaningfulness, and overall comprehensibility. Note that an underlying comprehensibility factor was independent of grammaticalness and meaningfulness! Carroll (1966) obtained judges' ratings of the "intelligibility" of sentences that were either human or machine translations of sentences from a Russian text; it was found that by pooling ratings of several judges, highly reliable measurements of intelligibility could be obtained, and that these pooled ratings were highly correlated with judgments of translation accuracy (and also, inversely, with reading times). While the judgments of comprehensibility obtained by Danks and by Carroll probably reflected the degree to which the judges actually comprehended the sentences, there is no guarantee of this. The method is focused on the potential "comprehensibility" of sentences rather than the actual degree to which judges understand them; it is of limited generality since it applies best

in a situation where the verbal materials show wider variations in grammaticalness and meaningfulness than are exhibited in ordinary utterances or texts. Schwartz, Sparkman, and Deese (1970) have used this technique for a wide variety of auditorily presented sentences and claim that it yields an index of comprehensibility that is "probably more sensitive and reliable than any word or sentence count readability index."

1.4 Evaluation of the truth or falsity of a statement. A time-honored procedure in various kinds of achievement tests is the so-called true-false item. Usually used in subject-matter achievement tests, it can also be used in tests designed to measure sheer language comprehension, particularly tests of foreign language competence. Because of the unreliability of the outcome, which can be influenced by guessing, this procedure is not recommended for assessing comprehension of a single message; furthermore, it can be applied only to statements whose truth or falsity will be immediately apparent to the subject once he has comprehended it. Nevertheless, Wason (1961) used this method in an experiment on the effect of grammatical negation; he presented sentences such as "87 is not an even number," "24 is an odd number," etc. and measured the latency of the judgments, pooling results over samples of such sentences.

1.5 Evaluation of centrality or importance of ideas in a passage. A number of reading or listening comprehension tests have used the device of asking the subject to identify those parts of a connected passage that are more central, important, or relevant to its main theme (Knower, 1945; Husbands and Shores, 1950; Abrams, 1966). Although this device may be useful in a test of comprehension ability, its validity and reliability for measuring

comprehension of the material is questionable, because it gets at comprehension only indirectly and could easily yield false positive or false negative results. It would appear to be more valid in measuring ability to make inferences from text materials.

1.6 Evaluation of importance of words in a sentence. Segal and Martin (1966) had subjects rate the importance of words in each of a number of sentences, finding a tendency for grammatical subjects to be rated higher than logical subjects regardless of the sentence transformation. The materials were all very easily comprehensible sentences. The procedure does not seem to be promising as a measure of comprehension; it was not designed for this purpose in any case.

2.0 Asking questions designed to test comprehension of verbal material on which the questions are based. One finds on nearly all standardized reading or listening comprehension tests the device of presenting a paragraph to read or listen to and then immediately asking a series of questions covering the content of the paragraph. (Ordinarily, on reading tests this paragraph is available to the subject as he answers questions. In listening tests the subject has to depend on immediate memory.) This procedure is used, for example, in the McCall-Crabbs Standard Test Lessons in Reading, Gates Reading, Tests, the Metropolitan Reading Tests, the Stanford Reading Tests, the Brown-Carlsen Listening Comprehension Tests, and many others. Since the object is to measure comprehension ability the selection of items is controlled by statistics concerning whether correct answers to a given item are correlated with generally high scores on the complete tests, or with some external criterion such as scholastic success. The precaution of insuring that the items cannot be

answered except at a chance level by an individual who has not read the paragraphs is not always taken. It is probably partly for this reason that the scores on these tests are quite highly correlated with measures of general verbal ability. Thus we can conclude that these are not pure tests of the comprehension of the particular paragraphs presented; they may also be tests of the ability to answer questions. Indeed, this type of test is often an integral part of "intelligence" tests such as the Scholastic Aptitude Tests sponsored by the College Entrance Examination Board.

The questions posed on such tests are ordinarily of the "objective" type--true-false, multiple-choice, or matching, but sometimes they are "essay" or "free-response" items. These item types vary in reliability and validity but they tend to give highly correlated results (Serling, 1967).

Tests of this type have often been used in various kinds of experimental studies on factors affecting reading or listening comprehension (e.g., Moore, 1919; English, Welborn, and Killian, 1934; Jenkinson, 1957; Coleman, 1964a; Jakobovits, 1965; Lee, 1965; and Dawes, 1966).

It has been claimed by some that depending upon the content and construction of the question, different kinds of reading or listening "skills" can be measured. Davis (1944), for example, claimed to be able to distinguish a number of separate skills such as ability to remember details, ability to make inferences, etc., but Thurstone (1946) demonstrated that Davis's data were well accounted for by a single dimension of reading comprehension ability. In a careful, recent study, Davis (1968) was able to show small but significant amounts of unique variance in tests designed to measure such skills as "recalling word meanings," "drawing inferences from content," and "following

the structure of a passage." (Inspection of the items for "following structure" shows that they are essentially measures of ability to use syntactic and grammatical-antecedent cues.) It may then be that particular test questions can identify different aspects of comprehension. Such a conclusion is supported by the work of Bateman, Frandsen and Dedmon (1964) who showed in a factor analysis of the Brown-Carlsen listening test that some items measured memory for details, while others measured the ability to draw inferences. But memory for details and ability to draw inferences are not really aspects of comprehension: memory for details is a function of attentional processes and of time lags between exposure to the material and the time of testing; the ability to draw inferences is logically distinct from sheer comprehension. In any case, Derrick (1953) was unable to find any clear separations among (a) the ability to answer factual questions, (b) the ability to "read-between-the-lines," and (c) the ability to make critical judgments. Nor was Derrick able to find that it made any difference whether the passages on which the questions were based were short or long.

If one is going to use questions to determine the degree of comprehension attained by reading or listening to verbal material, it is absolutely essential to insure that the questions cannot be answered (except at a chance level) by individuals who have not read or listened to the material that is to be presented. For some purposes, it may also be desirable to assure oneself that the content of the material is probably unfamiliar to the members of the group tested. Weaver and Bickley (1967c) point out that it is often the case that

> . . .reading comprehension tests are highly dependent on examinee characteristics which often have little to do with the reading task the examiner assumes he is presenting. Reading tests are measuring past learning, word association, irrelevance of distractors, and 'item conceptual-information constraints,' as well as the person's ability to answer multiple-choice items directly from cues in the reading display. The sources of variation are so confounded that two, or more, factors could be hidden here, and one would never know. Much of the confounding could be reduced by changes in methods of selecting items.

This remark applies equally well to methods of <u>constructing</u> items. What is needed is a design in which the questions are pre-tested on groups that have not been exposed to either the general or specific content of the material to be presented; questions that are equally likely to be answered correctly by both nonexposed and exposed groups are either rejected or changed until there are clear differences in the responses of the two groups. Such procedures have been used by a few careful investigators (Beighley, 1952, 1954; Fairbanks, Guttman, and Miron, 1957a). Marks and Noll (1967) present a technique that is to be highly recommended for evaluating items on reading and listening tests. By using the controls that they suggest, one can be reasonably certain that responses to comprehension items validly measure the degree to which the subject has been able to acquire new knowledge through exposure to verbal material. Use of this technique will also tend to control for the fact that some pupils have as much difficulty understanding the questions as they have in understanding the material on which the questions are based (cf. Piekarz, 1954).

Bormuth (1970b) has pointed out that achievement test questions can frequently be analyzed as grammatical transformations of material in the text. He urges that such items are easy to construct when viewed in this way and likely to be valid in measuring pure comprehension as opposed to inference.

3.0 Following verbal directions. Tests of the subject's ability to follow directions have appeared in intelligence tests (e.g., the well-known Army Alpha) but have rarely been used in experimental studies of comprehension, despite the fact that such tests could in many circumstances be highly valid measurements. In a realistic classroom experiment, Brown (1955) studied students' ability to listen to instruction concerning the spelling rules for doubling consonant letters before the suffix -ing and then tested for comprehension by having them spell a number of words ending in -ing. Jones (1966) investigated the effect of the negative qualifier except by having children perform a cancellation task under either of two instructions: "Mark the numbers 1, 3, 4, 6, 7" and "Mark all the numbers except 2, 5, 8." These two instructions were logically equivalent, since only the digits 1 through 8 were presented. Shipley, Smith, and Gleitman (1967) tested young (1 1/2 - 2 1/2 years of age) children's ability to respond to commands concerning pointing to objects and found that they failed to respond to commands containing nonsense words even when relevant meaningful words were retained in the command. Coleman (in press) has reported a series of studies on grammatical factors determining the length of time a child needs to read a printed instruction in order to be ready to perform an arithmetical task (e.g., "Subtract two from the mean of the rows); the child then performs the task to show comprehension. He recommends the following-directions procedure as one of the simplest and most valid methods for measuring comprehension.

With Coleman's recommendation we can agree, with the following reservations, however: (1) as with a number of other procedures, one must assure oneself that the criterion task cannot be performed unless the subject has been exposed to the instruction; (2) this procedure may be applicable only

in connection with a relatively limited range of verbal materials; (3) it may be difficult to exclude problems of memory and various performance factors--the individual may comprehend the instructions but forget them, or become confused, when he actually performs the task.

4.0 Measurements taken during reading. Various oral reading tests (Gates, 1953; Gilmore, 1951) illustrate procedures in which the comprehension of a paragraph is measured in terms of the child's ability to read it aloud without hesitations, mispronunciations, and the like. However, this technique seems to get at mainly the ability to decode print and is thus beyond the scope of this review.

On the assumption that an individual will attend to a reading selection only as long as he needs to gain the information it contains, a measurement of silent reading time may give an indirect indication of comprehension. We have already seen an application of this idea in the work of Danks (1969b), who measured the latency of a button press used by the subject to indicate comprehension of a simple visually-presented sentence. This idea has also been used by Weaver and Garrison (1966), who found significant differences in reading times for sentences as a function of the position of prepositions. Nevertheless, a subject will spend more or less time reading depending upon whether he expects to be tested. Kershner (1964) and Rothkopf (1968a) found that with repeated exposures to textual material college students took decreased time to read the material and at the same time made increasingly better scores on a "cloze" test of comprehension (see 9.1). Thus, reading time during the first exposure is not necessarily a valid indication of comprehension or of information gained during that exposure. Reading time can be used as a measure of comprehension only in special circumstances.

The same can be said for the eye-voice span, i.e., the amount of additional material that an individual reading aloud can report after illumination for reading is terminated. The technique has been used by Schlesinger (1966b), Levin and Kaplan (1966), and Levin and Turner (1966) to investigate the role of grammatical structure in the perception and comprehension of textual material; Schlesinger concludes, for example, that the eye-voice span typically reaches "to the end of either a syntactic constituent or of a 'chain,' which was defined as a group of words that the reader in his left-to-right perusal of the sentence might take to be a constituent" (p. 33).

Edfeldt (1960) has shown that experienced readers do not make subvocal movements (detectable by electromygraphic techniques) when reading easy material, but these movements become detectable when the material becomes difficult. Electromygraphic techniques, then, might be used to index the difficulty an individual has in understanding material he reads, but they would not provide a direct measure of comprehension, and might be affected by a number of other variables besides comprehension. Hardyck, Petrinovich, and Ellsworth (1966) report a technique for suppressing subvocal movements.

Patterns of eye movements are so variable within and among individuals that they show very little dependence upon the difficulty of material (Anderson and Dearborn, 1952, pp. 128ff.) and are therefore generally unreliable as indicators of comprehension. As reported by Miller and Isard (1964, fn. p. 299), however, Mackworth and Bruner were able to use eye-movements to index the difficulty of sentences. Highly self-embedded sentences were generally read with more fixation units than sentences not so embedded.

5.0 Verbatim recall. The study of recall is one of the best-developed areas in experimental psychology, but a great deal of the work has concerned the recall of relatively simple stimulus displays such as lists of nonsense syllables. The study of the recall of connected verbal discourse has received major attention only in recent years. We must consider what if any connection this has to do with the measurement of comprehension of verbal material. Logically, there is no necessary connection. One could, for example, comprehend a text and then immediately forget it. On the other hand, one might have perfect recall for a string of unconnected, incomprehensible words in a foreign language. The connections between recall and comprehension must be tenuous, or at least complex. In this section we will examine simply the techniques that have been used for the study of recall, with some preliminary comments on the extent to which these techniques yield valid evidence concerning comprehension.

5.1 Verbatim recall immediately after presentation. When the material is of very short duration, the subject can recall verbatim as a function of what is called memory span or short-term memory. Surprisingly, there is little direct evidence as to exactly what the memory span for verbal material (e.g., unrelated words) is; Miller (1956) reports data from Hayes to indicate that this memory span is above 5 (at least for monosyllables). As soon as there is any degree of semantic or syntactical organization in a series of words presented for immediate recall, the number of words that can be recalled correctly increases beyond the normal span (Marks and Jack, 1952). This is not to say, however, that short-term memory factors cease to operate.

Since memory span for young children is normally less than seven, even a grammatical sentence of seven words can tap the linguistic competence of a

young child; Binet's developmental scale of 1911 as cited by Terman (1916, pp. 37-39) included the following items:

Age 3: Repeats a (spoken) sentence of six syllables.

Age 5: Repeats a (spoken) sentence of ten syllables.

Age 15: Repeats a (spoken) sentence of twenty-six syllables.

The child passed the test only if reproduction was perfect. Terman used similar tests in his 1916 Stanford-Binet scale, but they no longer appear in the latest, 1960, revision (Terman and Merrill, 1960). However, tests for Repeating Thought of a Passage appear at the Superior Adult II and III levels; here, verbatim recall is not required, but the subject must give, in proper sequence, accurate reproductions of the "component ideas."

The experimental study of verbatim reproduction of longer passages (Henderson, 1903; Lyon, 1917; Clark, 1940) has generally depended on a scoring procedure known as the "method of retained members." The stimulus passage is divided into a number of phrasal units of approximately equal size; the subject's response is then scored in terms of the number of these units that are accurately reproduced. Sometimes partial credit is given for reproduction of the thought of a unit when it is not verbatim. Levitt (1956) showed that different investigators are likely to make different divisions of a passage and these differences are likely to be reflected in recall scores.

Indeed, the major difficulty with the study of recalls of connected discourse seems to be that of scoring. King (1960, 1961), King and Russell (1966), and King and Yu (1962) have reported a series of studies showing that when judges are asked to scale written recalls for excellence, two factors influence their judgments: a "quantitative" factor having to do with the amount of recall (number of words, and the like), and an "organization" factor

having to do with the quality and organization of the semantic content. This would mean, incidentally, that some judges are more influenced by quantity, others by organization.

One of the most perceptive studies of verbatim recall was by Gomulicki (1956), who presented his subjects with 37 prose passages, from 13 to 95 words in length. He studied the reproduction of each word, judging it as either "adequate" or "inadequate." Over the whole set of reproductions, 55.5% words were reproduced verbatim, 32.7% were omitted, 11.8% were changed, and 6.2% were added words or ideas. The frequency with which a given element was "adequately" represented was regarded as a measure of its "mnemic value." Mnemic value was then studied as a function of semantic content (action vs. description) and grammatical function. Recall was regarded as an "abstractive process" because the best remembered materials described actor-action-effect sequences; there was even a tendency for Ss to turn descriptive passages into "quasi-narratives."

Immediate verbatim recall of verbal materials has been used to study many aspects of language behavior and learning:

Basic processes in recall: Bartlett (1932), Paul (1959), to give only a few examples.

The effect of organization (order of approximation to English): Miller and Selfridge (1950), Deese and Kaufman (1957), Sharp (1958), Herrmann (1962), Tulving and Patkau (1962), Slamecka (1964), Knox and Wolf (1965), Cohen and Johansson (1967).

The effect of syntax and other grammatical factors: Miller (1962b), Martin and Roberts (1966), Robins (1968), Slobin and Welsh (1968).

The effect of various instructions as to what is to be recalled: Schwartz and Lippman (1962), King and Russell (1966).

The effect of associational factors: Rosenberg (1968e).

Method of reproduction: Clark (1940), Horowitz and Berkowitz (1967), King (1968c).

Oral vs. printed stimuli: King and Madill (1968).

These and other studies will be reviewed under appropriate headings later in this monograph.

5.11 Verbatim recall after a set of materials has been presented. A minor variation of the procedure presented in section 5.1 has been used in a number of experiments on the effect of syntactical factors in recall (e.g., Marks and Miller, 1964). A set of word-strings are presented to the subject in sequence; he is then asked to write them down in any order as accurately as possible. Actually, Marks and Miller carried out this procedure for five trials to trace learning over trials. Since learning occurred even for normal sentences it is evident that the procedure tests recall much more than comprehension; because of the simplicity of the normal sentences (e.g., "Rapid flashes augur violent storms") there is little doubt that they were comprehended on first presentation.

5.12 Prompted verbatim recall after a set of material has been presented. A further minor variation is to use the procedure in (5.11) but with "prompts." Mehler (1963), for example, gave Ss a set of eight sentences varying in grammatical transformation; after each trial, Ss were given prompts consisting of nouns in either the subject or predicate position.

5.13 Verbatim recall after a time period in which interfering stimuli have been presented. When the verbal material is extremely simple, it may be desirable to test recall by interposing distracting stimuli between the time of presentation and the time of recall. Wilson (1966) had children read either single words, 3-word syntactic strings, or 3-word non-syntactic strings, after which they were required to read ordinary text for 15 seconds before giving their recall of the stimulus.

Savin and Perchonock (1965) introduced a technique whereby the amount of grammatical material encoded in memory was claimed to be measured by the amount of additional material that could be remembered at the same time. A sentence was presented, followed by a string of eight unrelated words; the subject was to recall the sentence and then as many as possible of the eight additional words. However, Epstein (1969) has raised the question of whether Savin and Perchonock's results might equally well be explained in terms of difficulty in retrieval processes.

5.2 Delayed verbatim recall. Data on the accuracy of delayed verbatim recall of a prose passage presented only once are scarce.

In one of Slamecka's (1959) experiments on retention of connected discourse, subjects had a mean score of 12.8 (out of a possible 28) for immediate recall of a 28-word passage after one presentation; after a period in which they had to learn another, unrelated passage, their mean recall was only 7.1. This gives no indication of what their recall would have been if they had had no original recall and no interpolated learning. Common experience would indicate that verbatim recall of verbal materials after one presentation is not very good even immediately after the presentation, and decreases rapidly with

time, especially when the interpolated interval is filled with activities that tend to interfere with original learning.

5.3 Amount of time to memorize, with uninterrupted opportunity for repeated inspection. The amount of time to memorize verbal material depends upon the complexity of the material. This can be shown either by giving the individual a set amount of time to study and measuring the amount of recall, or by determining the amount of time the individual needs until he can reproduce the material to some given criterion of accuracy. Rubenstein and Aborn (1958), using the former procedure, showed that for 30 200-word passages culled from a wide variety of sources, the average learning score attained by a group of subjects was highly correlated with two readability indices applied to the passages and also with a "predictability" score (see section 9.2). Using the latter procedure, Follettie and Wesemann (1967) showed that learning time was related to various characteristics of prose passages (principally, their length in terms of grammatical units).

5.4 Repeated study-test learning trials, one stimulus at a time. In this procedure, the subject is repeatedly given learning trials consisting of a presentation phase (usually of constant duration) and a test phase (also usually of constant duration) in which the subject attempts to reproduce the stimulus either orally or in written form. The same stimulus is presented over the number of trials. The number of trials may be constant, in which case the learning score is the number of words recalled, and/or the number of errors (Sharp, 1958; Tulving and Patkau, 1962; Miller and Isard, 1964; Martin and Roberts, 1966; Rosenberg, 1968a), or it may depend on the performance of the subject in attaining a criterion of perfect reproduction, in which case the learning score is the number of trials to criterion (Epstein, 1961, 1962;

Coleman, 1965b; Bogartz and Arlinsky, 1966). In this type of study, an improvement in mean performance from an initially rather low level is universally noted. The design does not permit any appraisal of the extent to which the stimulus is understood on any of the presentations since measurements are concerned solely with the subject's success in retrieving the memory of the stimulus, i.e., in constructing the response correctly.

5.41 Repeated study-test learning trials, with sets of stimuli and free order of recall. This procedure is similar to (5.4) but a set of unrelated stimuli are given in the presentation phase; in the test phase S is allowed to recall these, as accurately as possible, but in any order he pleases. The effect of this procedure is to introduce (a) a certain amount of delay between presentation of the stimulus and the test, and (b) interference among the several stimuli in a stimulus set. These factors make the subject's retrieval task more difficult; they probably have little or no effect upon comprehension of the stimulus. A study illustrating the procedure is that by Martin and Roberts (1967).

5.5 Paired-associate learning. This classical procedure can be regarded as a method of prompted recall; it is particularly appropriate for studying the effects of relations between the "stimulus" and "response" members of pairs, or of relations among the several stimuli or responses in the set. There are two main varieties of the procedure. One is the "anticipation" method, in which a trial consists of the successive presentation of the paired stimuli (the "stimulus" member of each pair being presented before the "response" member); with succeeding trials, S is required to try to "anticipate" (say aloud) the response member of each

pair before it is actually presented. Illustrations of studies using this method are those by Martin and Jones (1965) and Martin, Davidson, and Williams (1965). The other method, illustrated by studies by Rohwer, Shuell, and Levin (1966) and Rohwer, Lynch, Levin, and Suzuki (1967), is the "study-test" method in which a list of pairs is presented to the subject for study for a specified amount of time, after which he is presented with the stimulus terms and asked to give the response terms.

5.6 Serial learning. In the usual verbatim recall experiment, a passage is presented to S to read or hear as a whole. Epstein (1962) wondered whether the organizational factors that facilitate recall of such materials as compared with unstructured materials would also facilitate learning when the materials are presented word by word in the conventional serial learning paradigm. The serial learning procedure consists of a series of trials; in each trial, the material is presented word by word (e.g., by memory drum), and with succeeding trials S is expected to learn to anticipate the successive words before they actually appear. Epstein found that sentences are no more readily learned in serial order than the same words in random order. Apparently the serial presentation prevents the subject from readily apprehending any syntactical structure in the material, while whole presentation does not. However, Epstein did not inform his serial-presentation subjects to look for structure.

5.7 Recall by paraphrasing or giving essential ideas. To ask the subject to give back the substance of a sample of verbal material "in his

own words" would seem to be a rather valid way of testing his comprehension. Yet, this method has been very rarely used in experimental studies of comprehension. There are at least three major difficulties with the procedure, at least if a strict paraphrase is required: (1) telling the subject to use his "own words" may place an extra burden on him when he can remember some of the words verbatim; (2) it is difficult to score paraphrases for content conformity to the original, as Downey and Hakes (in press) found; and (3) the procedure does not exclude the possibility that the subject may have difficulty in retrieving information even though it has been understood during original presentation. Clark (1940) found that even when Ss were asked to give verbatim reproductions, successive reproductions improved in quality even though the subject had no opportunity to re-inspect the original. Clark's experiment suggests strongly that retrieval factors are involved in any recall, but it also suggests that the validity of a recall test (whether it is to be verbatim or a paraphrase) could be increased by allowing the subject to make several successive attempts at reproduction.

Jones and English (1926) found that even after one reading of a 91-word passage, Ss were able to give an average of 71% of the 31 "ideas" regarded as contained in it. A similar procedure was used by Cofer (1941). In neither of these studies were the Ss instructed to avoid using the same phraseology as the original. They found, as might be expected, that recall of ideas was much easier than verbatim learning.

5.8 The "probe-latency technique." This technique was developed by Suci, Ammon, and Gamlin (1967) for investigating the role of phrase structure

in the apprehension of language. A subject is given a sample of verbal material, such as a sentence. This presentation is immediately followed by the presentation of one word selected from the sentence; the subject is required to think back to that word and give the word that followed it. The latency (time in seconds) of this response is measured. According to these authors, as well as Ammon (1968), the method gives results in line with certain expectations regarding phrase structure. While comprehension might facilitate performance of this task, the technique is not likely to be a sensitive measure of comprehension.

In sections 5.0 to 5.8, we have reviewed all the techniques utilizing recall and found them wanting in their ability to measure comprehension. From results on recall tests, it is generally difficult to tell to what extent any of at least three factors may be operating: (1) understanding of the material at the time of original presentation, (2) "storage" processes acting during original presentation to set the stage for recall, affecting either the semantic content of the material or the particular words used to express it, and (3) "retrieval" processes during the process of recall. In view of this, we recommend great caution in interpreting the results of recall tests as indications of comprehension.

6.0 Giving a translation of verbal material, with opportunity for continual inspection. A traditional way of determining whether an individual understands material in a foreign language is to ask him to translate it into his native language. One may also suggest that a way of determining whether an individual understands materials in his native language is to ask him to translate it into some foreign language that he knows. Such a method has rarely been used in studies of comprehension as such, however,

for the obvious reason that subjects are rarely expected to be sufficiently competent in a foreign language to perform the task. The method has considerable appeal because it offers the possibility of ruling out recall factors. Nevertheless, there would be difficulty in scoring translations, particularly in view of the fact that there are only rarely one-for-one translation equivalents between two languages.

7.0 Techniques depending on recognition. A traditional method of measuring learning and memory has been the recognition technique, whereby the subject who has learned something is then presented with some of the old stimuli together with some new stimuli and asked to indicate which are old and which are new. Some of the questioning techniques described under 2.0 depend upon recognition; at least, this is true of true-false questions and certain kinds of multiple-choice questions when they present material either unchanged or slightly modified from the original stimulus material and ask the subject, in effect, to indicate whether he recognizes the original stimulus material. Shepard (1967) has shown that college-age subjects are remarkably efficient in distinguishing new material from old material even when the old material is of considerable extent. For example, Ss were 89% accurate in identifying sentences they had inspected in a list of 612 clearly different sentences. All the sentences were, however, very simple to understand (e.g., "A dead dog is no use for hunting ducks."), so that one cannot say that the test was one of comprehension.

Nevertheless, the recognition technique has been used by several investigators to examine detailed processes of comprehension. Clifton, Kurcz, and Jenkins (1965), and Clifton and Odom (1966) used a recognition task to index the grammatical similarity of sentences; after presentation of a series of sentences, these same sentences together with slight grammatical transformations of them (negative, passive, question) were presented and the subject was asked to press a telegraph key whenever he thought he recognized one of the "old" sentences. The patterns of errors were found to correspond to some degree with the similarity of the sentences in terms of transformational distance, lending support to the "coding" hypothesis whereby sentences are stored in memory in terms of (a) their base forms, and (b) the transformations applied to them.

Lee (1965), Fillenbaum (1966), Newman and Saltz (1960), and Sachs (1967a, 1967b) have used the recognition task to find out the extent to which subjects remember the verbatim form of words or sentences versus their meanings. The evidence indicates, in general, that verbatim forms are remembered only for a relatively short time, whereas meanings are remembered much longer. All the materials used by these investigators were readily understandable in the original form (except possibly the longer paragraphs used by Lee). Thus, in these investigations the recognition task cannot be regarded as a test of comprehension. If the original materials were of greater difficulty, however, the recognition task might offer a useful measuring technique, inasmuch as sheer memory for meanings has been shown to be fairly long-lasting.

The "chunking" technique recently employed by Carver (1970a) can in fact be regarded as an application of the recognition task for materials

that are relatively difficult to understand. Carver's technique is to present a passage for reading, typically four or five paragraphs long. This is then immediately followed by a multiple-choice test. In each item of the multiple-choice test, each alternative consists of a "chunk" of the original--a clause, a phrase, or sometimes even a single word; one "chunk," however, is changed in meaning by the substitution of a different word or phrase. The subject has to indicate which alternative does not convey the original meaning.

An example will illustrate the technique. The first paragraph of one of Carver's selections is as follows:

> Voter apathy is almost a cliché in discussions of American politics. Yet, only a cursory look at voting and registration restrictions shows that many would-be voters do not cast ballots because they are prevented from doing so.

The test items covering this part of the selection are as follows:

1. (A) Voter apathy
   (B) is almost a cliché
   (C) in discussions
   (D) of American politics.
   (E) A recent poll directed
2. (A) at voting
   (B) and registration restrictions
   (C) shows that
   (D) many would-be voters
   (E) seldom protest or demonstrate
3. (A) because they are prevented
   (B) from doing so.
   (C)
   (D)
   (E) } [The remaining alternatives cover the beginning of the next paragraph in the selection.]

The changed alternatives are constructed and item-analyzed in such a way that individuals who have not read the original passage are unable to score

much above chance. The technique seems to have considerable promise, although it must be noted that the standardization and validation of the multiple-choice items is a fairly complicated process.

8.0 Techniques in which comprehension is tested by requiring verification against pictured referents. If a sentence is presented and the subject is asked either to tell whether a picture accurately represents its meaning or to choose one of several pictures that best represents its meaning, this would appear to have rather high validity in testing comprehension, apart from problems involved in guessing among the alternatives. The technique has been successfully used in a number of foreign language comprehension tests, and it is occasionally used in tests of listening or reading comprehension, particularly those for young children. An assemblage of such items constitutes a fairly valid and reliable test of comprehension ability. The technique does have several advantages: (1) it is "face valid," to the extent that the subject's ability to choose the correct picture reflects his actual comprehension of the message; (2) it is only minimally affected by differences in the subject's ability to read printed alternatives (this is particularly advantageous in the case of listening tests, but also applies in the case of reading tests); (3) alternative choices can be designed in such a way as to trap the subject who has only partial comprehension. Disadvantages of the technique are: (1) it is usually affected by a guessing component which makes it unreliable for testing comprehension of single sentences; (2) it is often inconvenient and difficult to prepare appropriate pictures; (3) it is limited to sentences or text materials that lend themselves to pictures, and even so, many concepts (e.g., tense relationships) are hard to represent by pictures, except possibly by moving

pictures or by cartoon sequences; (4) it is practically impossible to prepare pictures that will discriminate all the lexical and grammatical material that the sentence may contain; and (5) the technique may depend on pictorial perception processes of unknown complexity. Nevertheless, with appropriate care, the technique is highly useful in many circumstances.

In several cases, it has been used in experiments concerned with processes in sentence comprehension. Gough (1965, 1966) had subjects verify sentences against pictures, under two conditions: (1) the picture was presented coincident with the beginning of the final word of the auditorily presented sentence, or (2) the picture was presented three seconds after the termination of the sentence. Even when the picture was delayed, active sentences were verified faster than passive ones, and affirmative sentences faster than negatives, contrary to what one might expect if it is supposed that the hearer immediately decodes a complex sentence by transforming it into its underlying structure. Slobin (1966) has used a similar technique, finding that one of the primary determinants of whether passives are not as readily verified as actives is whether the action is "reversible" (e.g., both the cat chases the dog and the dog chases the cat are possible) or "non-reversible" (e.g., the girl waters the flowers is possible but the reverse is not).

9.0 Techniques depending upon context and redundancy. One of the standard tools in mental testing is the "completion item," where the examinee has to fill in a missing element from the context that is given. As used on "intelligence" tests, the context is carefully selected so that only one response is acceptable--or at most a very limited number of them. The context in this case is often a definition or a sentence that describes some situation where only one particular word to be filled in "makes sense."

Use has also been made of the opposite technique--i.e. inserting or substituting in the text a word or phrase that "spoils the sense" of the message, and asking the examinee to identify it. Apparently this technique was first used in the Chapman-Cook Speed of Reading Test (1923); the examinee's speed of reading is indexed by how rapidly he can work through a passage or series of passages and find the extraneous items. Such a procedure has certain objections: it is not a normal form of reading task since the unwanted items spoil the meaning and may be a distraction; and sometimes by adopting a certain appropriate strategy, the subject can identify the incorrect items without really comprehending the passage.

9.1 The (standard) "cloze" technique. Introduced, or as some would have it, re-introduced by Taylor (1953) as a convenient and reliable measure of "readability" (a characteristic of text material), the "cloze" procedure has also gained some acceptance as a measure of individuals' degree of comprehension of material (Taylor, 1957). The procedure involves taking a passage of text material and deleting words in it by some rule, e.g., every nth word, every noun, or the like. Most frequently, n is set equal to five, when systematic deletions are made, but other values, up to n = 12, have been used. The pupil is then presented with the passage and asked to try to guess the missing words. Usually the passage is presented in written form, in which case the missing words are indicated by blanks of a standard size. Peisach (1965), Dickens and Williams (1964), and Weaver and Kingston (1963) have demonstrated the feasibility of administering the cloze technique in an auditory mode: the passage is recorded on tape and specified words are replaced by some special signal (e.g., a white noise) plus time for recording

answers, or the test is administered orally by a teacher who tells the pupils to guess a word whenever she claps her hands.

Various types of scoring procedures are employed. Usually, the score is based on the number of words in the original that the subject is able to guess exactly (aside from insignificant number/tense changes or spelling errors). Such a score has the advantage of being objective, and it has been found to correlate highly with other types of scores, such as those where words of similar meaning, or of similar grammatical function, are allowed as "correct" responses. However, the type of score that is most advantageous may depend upon the purpose of the cloze test. For purposes of measuring "readability" or "listenability," where the average score for a passage is obtained from a considerable number of readers (say, 25), the score based on exact word replacements may be very satisfactory. Likewise, for measuring general comprehension ability, where the individual's score is based on a large number of items and passages, the strict scoring criterion is most convenient and probably as valid as other scores. But for measuring an individual's comprehension of a particular passage, the more relaxed types of scoring may be more satisfactory. There has not been enough research on methods of scoring for an individual's comprehension of a passage.

In most applications, the cloze procedure involves presenting the doctored passage "cold"; that is, the subject is not given advance opportunity to read the passage in its unmutilated form. He is supposed to guess words on the basis of the context or redundancy in the passage. His success or failure in doing so is partly a function of the inherent difficulty of the

passage (including the inherent difficulties of guessing the deleted words) and partly a function of his general comprehension ability, which in turn may be a function of many factors--his verbal intelligence, his maturity, education, and experience, and perhaps, according to the results obtained by Weaver and Kingston (1963), a special aptitude for utilizing the redundancy in the passage. When the cloze scores are based on systematic deletions, a number of investigators (Taylor, 1957; Jenkinson, 1957; Greene, 1965) have found moderate to substantial correlations of cloze scores with various measures of reading ability. However, Rankin (1958) concluded that cloze tests in which the deletions are restricted to nouns and verbs are "not very accurate" measures of general reading skill. Weaver and Kingston reported that even though cloze scores may have moderate correlations with certain measures of verbal intelligence, all eight of their cloze scores, obtained with various types of material and with both auditory and visual presentation, formed a factor-analytic cluster that they identified as "redundancy utilization" ability.

Thus, when the cloze procedure is used to measure comprehension of a passage in mutilated form, without prior exposure to the unmutilated form, the score cannot be a pure measure of comprehension. One would at least have to control for "redundancy utilization ability" on a sample of passages and use that as a baseline for determining an individual's comprehension of a particular passage. The complicated problems of equating involved in such measurements have not been adequately treated in research so far. By certain simple scaling techniques, Bormuth (1968a) found that if a pupil answered 43.6% of the words on a cloze test, it was equivalent to answering 75% of

the questions on a more standard multiple-choice test of comprehension; his result was based, however, only on the paragraphs and questions in the Gray Oral Reading Test and may not be widely generalizable. Furthermore, this result was intended to be applied only to assessing the readability and grade-level suitability of instructional materials, not to assessing a particular child's reading comprehension.

It has often been pointed out that the cloze technique measures a rather superficial kind of comprehension--the ability to follow the detailed ideas and grammatical patterns that occur within sentences or closely adjacent groups of sentences. There is no clear evidence that it will necessarily measure the ability to comprehend or learn the major ideas or concepts that run through a longer discourse.

Numerous investigators have used cloze scores as a dependent variable in the comparison of groups with different treatment or selection conditions. In such investigations, it is possible that the confounding variables were washed out and the results with the cloze scores may be taken as valid. For example, Peisach's (1965) finding of social class and sex differences in 5th-grade children's ability to comprehend the speech of their teachers is probably sound. On the other hand, a question may be raised about Tatham's (1967) finding of differences in comprehension depending upon whether "high frequency" or "low frequency" language patterns were used, inasmuch as the cloze scores may have reflected nothing more than the "frequency" of the language patterns; the results would be of significance only if the cloze scores reflected comprehension of passages <u>apart</u> from the particular language patterns used.

Sometimes cloze scores are used to measure gain in knowledge, as when an unmutilated passage is presented, followed by a "cloze" test on the same passage. Coleman and Miller (1968) found that cloze scores based on systematic (every 5th word) deletions were unsatisfactory for measuring knowledge gain, since the scores were hardly higher, on the average, than scores made by individuals who had not seen the unmutilated passage. Greene (1965) reported the same to be true of cloze test scores based on noun and verb deletions. These findings are slightly at variance from those of Rankin (1958), who compared noun-verb deletion scores with systematic (every 12th word) deletion scores; the former he found to be "sufficiently accurate" for measuring specific gains in comprehension and knowledge, while the latter were not. Rothkopf (1968a) used content-word deletion cloze scores in showing that the proportion of correct responses was an increasing but negatively accelerated function of the number of times a student was allowed to read a written passage. More research is needed on types of cloze scores that will show knowledge gains when subjects are allowed to inspect an unmutilated passage in advance of a cloze test, and/or on the conditions that determine whether knowledge gains will be exhibited by such scores.

In view of the grossness of cloze-procedure measures, it is somewhat remarkable that they have been so successful in many circumstances. Their success is achieved, in all probability, by the averaging of performance over many separate items. There are indications that a more detailed analysis of the responses in cloze tests would be worthwhile. Jenkinson (1957) attempted to classify the kinds of clues that students use in performing cloze tests, also studying the kinds of errors made and what those errors

indicated about sources of misunderstanding. A summary of her classification of clues is as follows:

I. Structure
   1. Syntactical
      a) recognition of function words, parts of speech and word order
      b) recognition of punctuation and accurate location of referents
      c) errors of word recognition
   2. Awareness of language
      a) sensitivity to sound (as in poetry)
      b) sensitivity to style--appreciation of exactness of expression, recognition of rhetorical devices and the style of the author

II. Semantic
   1. Literal
      a) identification of meanings of words, idioms, and groups of words in context
      b) identification of direct meanings of the whole passage
   2. Contextual
      a) anticipation of ideas and meaning
      b) retrospection to check meaning
      c) extension and reconstruction of meaning
   3. Ideational
      a) fusion of separate meanings of words or groups of words into ideas
      b) recognition of the sequence and interrelationship of ideas
      c) recognition of implied meanings

III. Approach
   1. Effort to obtain closure
      a) verbal closure
      b) negative
      c) tentative
      d) awareness of error
      e) verbal fluency and flexibility
   2. Use of experiential background
      a) general
      b) egocentric
   3. Intellectual
      a) imagining
      b) reasoning, analyzing, judging
      c) problem solving

More research needs to be done on the factors involved in guessing missing words. Rothkopf (1962) found that performance was best when deleted words were near the end of a sentence; this conforms to Forster's (1966) finding it is easier for a subject to provide an ending for a sentence already

started than to provide a beginning for the ending of a sentence. Pike (1969) has made a detailed analysis of certain kinds of grammatical constraints on filling in words in certain kinds of sentences. Such information should be of help in constructing more valid cloze tests.

9.2 Progressive cloze technique. I suggest the name "progressive cloze" for a technique that has been used occasionally for scaling the difficulty of materials. It is modeled after a procedure introduced by Shannon (1951) for measuring the redundancy of English. Shannon had subjects try to guess a passage letter by letter. That is, they were told to guess the first letter; the number of their guesses until they got it right was recorded; they then tried to guess the next letter, etc. Rubenstein and Aborn (1958) had subjects try to guess a passage word by word. They allowed only one guess per word and measured the difficulty of the passage in terms of the percentage of words correctly guessed by a group of subjects. They showed that "predictability" scores for passages obtained by this method were highly correlated with readability and learning scores obtained from other groups of subjects. The technique has been used by others (e.g., Slamecka, 1964; Cohen and Johansson, 1967, with Swedish) for scaling learning difficulty. Foppa and Wettler (1967), working with German, found that predictability scores were higher for sentences with complicated syntax, however. Whether this was true because of the special characteristics of the German language is as yet not known.

Coleman and Miller (1968) found that this technique was suitable for measuring information gain in individual subjects. Essentially, their procedure had the subject make two trials with the same passage. On the first

trial, he was asked to guess the passage word by word. He was allowed only one guess per word. According to Coleman and Miller:

"If he guessed wrong, he was told the correct answer, and then he attempted the next word. The measure of what he knew about material he had not read was simply the number of correct guesses per hundred words.

"As the subject proceeded through the passage guessing every word, he must have studied it most carefully. As soon as he finished, he went through the passage again, guessing each word. The difference in correct words on his first and second attempt is a measure of IG [information gain]."

The mean percentage of words guessed on the first trial was 33.73; on the second trial, 72.66. The scores in the second trial correlated only .57 with the scores on the first trial. However, these results were based on only 9 subjects and there were no external criteria of validity. One can only say that the method shows promise.

10.0 Construction and rearrangement tasks. As long ago as World War I, when the Army Alpha Intelligence Test was constructed, a favorite method of testing verbal intelligence has been to present a sentence with the words scrambled. In current terminology, such sentences exhibit a type of grammatical anomaly. Until recently, little study has been made of the psycholinguistic processes involved in performing the task of reconstructing the sentence. Clearly, there are individual differences in ability to perform the task. Oléron (1961) presented subjects with scrambled groups of (French) words; they were told that the words, when put into their original order, constituted news items in a telegraphic style. Subjects had increasing success in reconstructing the texts when the words were grouped by twos or threes in their original order. This method permitted study of the roles

played by grammatical factors and verbal associations. Similar work has been done by Bever (1968) with scrambled sentences in English. For certain types of materials, ability to reconstruct a scrambled passage would appear to be a good criterion of comprehension, but it points up the fact that subjects do not necessarily use simple syntactical (word order) elements in comprehension; rather, they use their knowledge of the syntactical and semantic structures which particular lexical items are most likely to enter. Ordinarily, the reconstruction task has been applied to single sentences. Pfafflin (1967) found that Ss could re-order sentences that had been scrambled within a paragraph.

CONCLUSIONS ON THE MEASUREMENT OF COMPREHENSION

We have surveyed a wide variety of techniques that have been used by investigators to study language comprehension and the factors involved in it. It is evident that no one technique is universally valid for measuring comprehension; each technique has its own particular sphere of appropriateness. A number of distinct purposes can be discerned in the investigations surveyed:

(1) Measuring the general comprehension ability of individuals;

(2) Measuring the degree to which an individual comprehends a particular sentence or passage;

(3) Investigating the psycholinguistic processes in the comprehension of textual materials;

(4) Measuring the "comprehensibility," "readability," "listenability," or "learnability" of samples of textual materials;

(5) Measuring the "grammaticality" or "communicative acceptability" of samples of textual materials.

In general, any one of the techniques might be used for any of the above purposes, but for each purpose there are certain "methods of choice."

Measuring comprehension ability. Measurements of comprehension ability must be based upon a substantial sample of materials ranging widely in difficulty, in order to produce scores that are reliable and that accurately indicate the general level of difficulty that the subject is able to comprehend. The "methods of choice" are mostly the traditional ones, such as multiple-choice items, but several newer or more unusual techniques may also be considered. In approximate order of general usefulness, these methods may be recommended:

2.0 Asking questions designed to test comprehension--provided that the questions have been adequately pretested to exclude the possibility that they are either too easy (and can generally be answered without exposure to the material on which the items are based) or too hard (pose problems extraneous to that of comprehending material)

3.0 Following verbal directions

8.0 Verification against pictured referents

9.0 Techniques depending upon context and redundancy--

(a) the standard cloze technique, with deletion of every nth word, where n may range from about 5 to about 12

(b) Carver's "chunked" comprehension test

(c) Insertion or substitution of words to "spoil the meaning"

1.4 Evaluation of the truth or falsity of a statement

1.5 Evaluation of the centrality or importance of ideas in a passage

10.0 Construction and rearrangement tests (generally applicable only for written tests)

It will be noted that tests of memory or recall are not recommended for measuring comprehension ability.

Measuring the comprehension of a given text. Most of the techniques listed above for measuring comprehension ability are also appropriate here, except that even more attention has to be given to the pretesting of the materials. However, one should probably exclude the techniques listed under 9.0, "Techniques depending upon context and redundancy," since the measures yielded here are too unreliable to be useful for evaluating comprehension of a single text unless the text is fairly extensive. Also, some of the techniques may be inappropriate for a particular text, e.g., one whose meanings are not readily picturable, or one that does not lend itself to having the subject follow verbal directions based on it. Again, tests of memory or verbatim recall are not recommended, except that asking the subject to give a free paraphrase of the text may have advantages in certain cases. The disadvantage of the paraphrasing task is that it is hard to score accurately.

Investigating psycholinguistic processes. Almost any of the techniques considered in this chapter can be of use in psycholinguistic investigations of discourse comprehension, and I will not attempt to discuss them in detail in this context. One caution may be mentioned, and that is that tests of recall are very likely to be deceptive in that they fail to distinguish between comprehension at the time of initial presentation and ability to retrieve or reconstruct information at the time of recall.

Measuring the comprehensibility of texts. The history of methodology in

measuring comprehensibility (readability, listenability) seems to have been characterized by a progressive substitution of one preferred technique for another. Originally, the "method of choice" was asking comprehension questions (method 2.0), but this was replaced by various stylistic analysis counts when it was found that the latter could reasonably well predict the former. We have not discussed these techniques above because they are not direct measures of comprehension or comprehension ability; they deal only with the characteristics of texts. More recently, however, the cloze technique in one or the other of its forms has tended to be the method of choice because of its simplicity (apart from the bother of administering and scoring cloze tests) and apparent validity. The cloze technique is currently the most favored technique, despite its unwieldiness. It may yet turn out, however, that subjective judgments of the sort used by Carroll (1966) or Schwartz, Sparkman, and Deese (1970) may come to replace the cloze technique as a method of choice.

Assessing grammaticality or acceptability. Strictly speaking, one cannot assess grammaticality except by grammatical analysis in terms of a particular grammatical theory. "Acceptability," however, can be assessed, but only, almost by definition, by subjective techniques. An extension of these subjective techniques occurs when subjects are asked to "correct" the grammar of a sentence, as did Quirk and Svartvik (1966) and Danks (1969b).

THE MEASUREMENT OF LEARNING FROM DISCOURSE

On the assumption that "learning from discourse" means "assimilation of meanings into a long-term memory store," the measurement of such learning must carefully distinguish between "comprehension at time of original

presentation" and "comprehension after a delay." Just what period of time is referred to when we speak of "delay" must depend upon the circumstances; we will review in Chapter 7 what is known about the retention of verbal meanings after various delays. Various recall, recognition, and reconstruction techniques are available for the measurement of retention. A sharp distinction has to be drawn between "rote" memory and "logical" memory, to use terms employed by Welborn and English (1937) and Cofer (1941), that is, memory for verbatim content vs. memory for meaningful content. A further distinction is that between learning ("what has actually been stored") and performance (what the individual can retrieve from memory, and what he can do with it). The tough problem for the would-be measurer is to determine exactly what is perceived or comprehended at the time of original presentation and what residual perceptions or comprehensions remain at the time when retention is tested. In many studies of retention, there has been a failure, either partial or complete, to determine what was comprehended at the time of original presentation. This must be borne in mind in the subsequent discussion.

Chapter 4

MESSAGE AND SOURCE-OF-MESSAGE CHARACTERISTICS

This and the following four chapters will examine the major types of factors in comprehension of, and learning from MVD. For purposes of analysis and exposition, these factors have to be discussed one by one. We will try to avoid artificiality in such an analysis by considering the relations between the factors as we proceed.

The Comprehensibility of Texts

What aspects of a text--its vocabulary, syntax, organization, style, content, etc.--make it relatively easy or difficult to understand as compared with other texts, holding constant such factors as the individual's competence with the language, his motivation to comprehend, his background knowledge, his interest in the material, etc.?

Much of the research on this question has been conducted in the context of trying to assess the comprehensibility of <u>printed</u> texts, i.e., their "readability." We know much less about the comprehensibility of materials presented auditorily--i.e., their "listenability." This has led to some confusion, in the sense that the readability of printed texts depends to a substantial degree on the reading ability level of the reader, or more specifically, on his ability to "decode" language from print. The characteristics of printed texts that make them difficult to comprehend are in some measure (at least for not-fully-skilled readers) those characteristics that make them difficult to decode into spoken language. Because of the vagaries of its orthography, English presents special difficulties in this respect;

we might expect somewhat different results if we were dealing with a language (e.g., Spanish or Finnish) whose orthography is more regular than that of English. One might wish that research on comprehensibility of texts in English had been initiated with orally-presented texts. Such research would have disclosed more readily the characteristics of language that present difficulties in understanding apart from the decoding of print. The research could then have proceeded to investigate comprehensibility of written texts, noting those aspects of difficulty that may be peculiar to written or printed language. Instead, research has tended to proceed in the other direction: after a long period of research on readability, some efforts were made to apply the results to the comprehensibility of orally-presented texts. Only in recent years has there been some interest in the comprehension difficulties in orally presented materials.

It should be pointed out that there are likely to be comprehension difficulties peculiar to oral texts, for example, those connected with homophones (different words, perhaps differently spelled, which are pronounced with the same phonemes). Furthermore, research on the comprehensibility of orally-presented materials involves special problems such as the control of articulation accuracy, intonation and stress, dialect, signal-to-noise ratio, and speech rate.

However, a large proportion of the characteristics that make oral language difficult are the same as those that make printed language difficult. With appropriate caution, we can generalize at least some of the results obtained with "readability" research to oral language. Because of the extensiveness of readability research, our review will examine it first.

Readability Research

Chall (1958), who made a detailed and scholarly review of the research that had been done through about 1953, indicates that early in this century the interest was in assessing textbooks and supplementary reading material for the school grades; in the 1930's the needs of adult education prompted study of ways to identify easy reading for adults, and in the 1940's journalists and others concerned with mass communication media joined in pursuing this kind of research. Nevertheless, the basic techniques and assumptions have remained relatively the same until very recent years. The major assumption has been that linguistic elements--words, sentences, and other objectively identifiable features in prose--can be counted and somehow weighted to produce a "readability formula" to indicate the reading ease or grade level of the material. In order to devise a mathematical prediction formula, it was necessary to have available an initial criterion of reading ease. Sometimes the criterion was purely judgmental. A somewhat more objective criterion was provided by measurements of readers' ability to answer questions covering reading material. A favorite criterion of this sort was the scale of reading difficulty, based on pupil's success in answering comprehension questions over the material, provided by the McCall and Crabbs (1926) series of paragraphs. A large number of formulas have been developed and widely used to evaluate textbooks and reading material. Chall (1958) compares the merits and demerits of many of them; a somewhat more recent, but also very comprehensive, review has been provided by Klare (1963). Most investigators attempted to develop formulas that would be applicable over a wide range of reading difficulty, but

because of the materials and techniques employed, some were more appropriate at lower levels, others more appropriate at upper levels. On the basis of considerable research evidence, Chall concluded that "when used to appraise materials of intermediate-grade difficulty, the Lorge, Flesch, and Dale-Chall formulas assign similar grade-levels, which average well within one grade of each other," but that "above the seventh grade ... the Lorge formula tends to give considerably lower indexes than the Flesch and Dale-Chall formulas, the discrepancy becoming larger as the difficulty of the material increases" (Chall, 1958, p. 95).

Klare (1963) regards the Dale-Chall formula as the most accurate, the Farr-Jenkins-Paterson as the most convenient and easy to use, and the Flesch Reading Ease formula as the most popular. He also makes several recommendations regarding formulas for use in measuring special characteristics of material (e.g., abstraction level), or for use in special circumstances (e.g., measuring the difficulty of psychological tests and inventories), and mentions special formulas for the readability of material at the beginning reading level.

Chall and Klare have also discussed the validity of the formulas. With the original criteria by which they were established--usually, the McCall-Crabbs paragraphs, the formulas had correlations of about .70. Powers, Sumner, and Kearl (1958) recalculated four formulas using the 1950 edition of the McCall-Crabbs paragraphs, with the following multiple correlations corrected for degrees of freedom:

Formula	Multiple Correlation	Proportion of Variance
Flesch Reading Ease	.6351	.4034
Dale-Chall	.7135	.5092
Farr-Jenkins-Paterson	.5837	.3407
Gunning Index	.5865	.3440

All four recalculated formulas agreed much more closely with one another than the original Dale-Chall and Flesch formulas did. Nevertheless, these calculations may tend to overestimate the validity of the formulas because they merely reflect the capacity of the formulas to correlate with the criterion on the basis of which they were developed. The evidence on the validity of the formulas against "external" criteria is much more mixed. Although there are more positive results than otherwise against such criteria as reading comprehension, reading speed, readership, and writer ability, it cannot be said that the readability formulas available at the time of Klare's review were of impressive validity. Klare (1963, p. 155) stated that if attention is restricted to "modern" studies (those appearing in 1946 or later), 35 had positive results, 9 "negative" (i.e., with correlations less than .50), and 9 "indeterminate."

Chall (1958, p. 157) pointed out that "of the diverse stylistic elements that have been reliably measured and found significantly related to difficulty, only four types can be distinguished: vocabulary load, sentence structure, idea density, and human interest." Of these factors, vocabulary load "is most significantly related to all criteria of difficulty so far used." Klare (1963) feels, with probable justification, that "human interest" is not logically related to actual comprehension

difficulty; hence this factor should probably not be considered within the scope of comprehensibility measurement. Factors falling roughly in the areas of "vocabulary load" and "sentence structure" accounted for most of the variance in two independent factor analyses (Brinton and Danielson, 1958; Stolurow and Newman, 1959) of data originally published in 1935 by Gray and Leary. The opinion seemed to be widespread, early in the 1960's, that further progress in the measurement of readability could be made only be refining measures of the limited number of factors that appeared to determine it.

The results of readability assessment were often counter-intuitive. For example, Stevens and Stone (1947) found that Koffka's notoriously difficult psychological writings were evaluated as "quite easy" by the Flesch formula, while William James's pleasant and easily-read writings were evaluated as quite difficult. Lockman (1956) actually found negative correlations between Flesch readability formula results and rated "understandability." There were also justified warnings and cautions about the uncritical use of readability measurements, either in the selection of children's literature of the writing of "more readable" prose. Both Chall and Klare, in their reviews, stated that the manipulation of the elements of readability counted by the formulas could not be relied upon to produce more readable prose: Klare recommended that readability measurements be applied only post hoc--to measure the readability of something already written, not to guide its writing. Nevertheless, the works of Flesch and others were widely influential in getting writers of material for education, business, or government to write with smaller vocabulary loads and simpler sentence structures.

Such was the state of readability research and application around 1960. The publication of Chall's review in 1958 marked the beginning of an era of intensified research. At least three trends began to be evident:

(1) Completely unmentioned in Chall's review, and given only scant attention by Klare, the work of Wilson Taylor (1953) on the "cloze" technique attracted wide interest. The "cloze" technique was offered not only as an improved criterion measure for readability research, but also as a convenient and more valid measure of readability itself. (Its importance was minimized by Klare because it did not fit within his definition of a "readability formula.")

(2) The advent of greater precision in syntactical analysis through developments in linguistics made more refined study of sentence complexity possible.

(3) Advances in technology and in computer analysis of text made it possible to foresee the computerization of readability measurement (Smith and Senter, 1967; Shaw and Jacobson, 1968; Klare, Rowe, St. John, and Stolurow, 1969).

Taylor's judgment, in 1953, that "... a cloze score appears to be a measure of the aggregate influences of all factors which interact to affect the degree of correspondence between the language patterns of transmitter and receiver," and thus to be an adequate measure of readability, seems to have been reasonably well borne out by more recent research. In 1968, the National Council of Teachers of English, in cooperation with the National Conference on Research in English, published a pamphlet (Bormuth, 1968b) that reprinted a number of articles on readability, mainly oriented

around the use of the cloze technique (Bormuth, 1967b, 1968b; Klare, 1968; Coleman, 1968a, 1968b). Bormuth claimed at that time that "the readability formulas available only three years ago could, at best, predict only 5 to 50 percent of the variation we observe in the difficulties of instructional materials," while "today, we have not one but several prototype formulas which are able to predict 85 to 95 percent of the variation." Bormuth was referring to his research (Bormuth, 1966b) in which a wide variety of linguistic variables were used to predict cloze measures of 20 passages selected to represent a wide variety of prose styles, with a roughly even distribution in Dale-Chall readability from about 4.0 to 8.0 in grade level. Multiple correlations, even with as few as four variables, ranged up to .934.* Some variables, particularly those involving word counts, were found to have a curvilinear relation to the criterion. Little evidence was found for differential validity of readability elements at different levels of reading ability. Bormuth felt that further refinement of his results would make possible new readability formulas that would be not only highly accurate and valid, but also easy to compute and use.

The reasons for the great "breakthrough" in readability measurement, according to Bormuth, were (1) the availability of the cloze technique as an improved criterion of comprehensibility, and (2) the availability of new linguistic variables that could be applied to readability measurement. In Bormuth's 1968 article, it was stated

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*Such correlations must be viewed with some caution in view of the small N on which they are based.

"we have now learned enough to design much sounder readability formulas"; however, an improved readability formula for general use has not yet been promulgated. In any case, Bormuth believes that "most future readability formulas will probably be designed to provide a profile of the level of difficulty represented by each of the language features in a passage."

The successes apparently achieved by this research have given new encouragement to the idea that elements of language found to cause comprehension difficulties can be manipulated in order to prepare material that will be more readable (Coleman, in press), or even more learnable (Coleman and Miller, 1968). This idea has yet to be tested extensively; it may be that manipulation of some of the newer linguistic variables will prove more effective than that of variables that entered the older readability formulas.

The enthusiasm generated by the recent readability research must be tempered by certain considerations:

1. How valid is the cloze technique? This matter has already been considered in Chapter 3, where it was pointed out that while the customary cloze technique (systematic deletion of every 5th word) produces scores that correlate satisfactorily with reading comprehension, scores involving only lexical (content word) deletions do not correlate with reading comprehension ability. Further, it was noted that cloze scores are apparently complex, reflecting not only reading comprehension ability but also a special ability to utilize redundancy in a passage. It was also noted that cloze scores do not ordinarily measure information gained from a passage, but simply the understandability of the passage during actual exposure to it. Now, these

possible defects of the cloze technique probably are largely irrelevant to readability research, where passages are graded in comprehensibility by averaging scores over readers, because variations in "redundancy utilization ability," if such exist, or in actual learning from the passage would balance out through randomization. Nevertheless, if the researcher is interested in grading passages for aspects other than sheer comprehensibility, he would be well advised to try the "progressive" cloze procedures utilized by Rubenstein and Aborn (1958) or Coleman and Miller (1968), or the procedure of deleting only content words employed by Rankin (1958). The usual cloze procedure may be thought of as a technique for detecting what may be called "local comprehensibility," i.e., the comprehensibility of individual sentences in their immediately surrounding contexts. To the extent that systematic deletions touch function words, cloze scores are not likely to be sensitive measures of comprehension of main ideas and conceptual organization in prose.

2. How do cloze scores interact with the overall readability level of the material? No clear demonstration is available that the same processes of comprehension operate for materials of high and low difficulty.

3. How do cloze scores interact with the characteristics of readers? Bormuth (1966a) attempted to answer this question by stratifying his sample of elementary school children according to reading ability and calculating interactions between ability level and various linguistic indices. A number of significant interactions were found, particularly for indices concerned with words (as opposed to clauses and passages

as a whole), but he attributed most of these to ceiling effects. His conclusion was that in general the same elements caused comprehension difficulty at all the levels of reading ability he identified in his samples. Bormuth's evidence is not sufficient, however, to rule out the possibility of meaningful interactions between cloze scores and reader characteristics. His reading ability levels were limited to those found from the 4th to 8th grade in a typical school system; they may not, therefore, have included very low or very high levels. Bormuth also failed to report whether the cloze scores themselves were linearly correlated with reading levels. Even if they were, curvilinearity might have arisen if a wider range of reading levels had been included. Bormuth (1968a) reports a number of very high correlations between cloze scores and various other measures such as conventional multiple-choice comprehension tests--correlations that approach unity when corrected for attenuation. However, these data were collected exclusively on elementary school students. Research using the cloze technique needs to be extended to include very high and very low reading ability levels. Coleman (1968a) worked with several variables such as word spelling and phonic regularity that may be peculiarly associated with readability at low levels of reading ability.

4. <u>How practical will it be to use cloze scores for other than research purposes</u>? The advantage of a reading formula is that it can be applied directly, in the quiet of one's study, to measuring the readability of a text. Use of the cloze procedure, on the other hand, involves testing a group of readers, preferably varying considerably in reading ability, and averaging the results. Even after this process,

however, the scores may have no absolute meaning. Bormuth (1968a) attempted to remedy this situation by statistically equating cloze scores to more conventional criteria of understanding. Two levels were chosen, (1) the "instructional level," traditionally understood (according to Bormuth) to be reflected by the ability to answer 75% of comprehension questions over a passage, and (2) the "independent study" level, represented by ability to answer 95% of questions over a passage. A cloze score of 44% (based on systematic deletions of every 5th word) was found to be equivalent to the "instructional" level, and a score of 57% to the "independent study" level. These results are only a partial remedy for the problem; what is needed is a study of the equating of the full range of cloze scores to reading grade levels or the like, for groups of given characteristics. For example, an appropriate table of results would make it possible to find the appropriate grade level of a passage, given the average cloze score attained by pupils in any given grade.

Listenability

In the 1950's, specialists in oral communication began to take an interest in the "listenability" of materials presented orally. Texts to be presented orally were subjected to some of the same "readability" analyses that had been traditionally applied to reading materials. The evidence is very sparse as to whether such application of readability formulas is generally valid for the appraisal of whether a text is more "listenable" when presented orally. Part of the difficulty, of course, is that oral presentation of material entails

two opposite effects: on the one hand, it eliminates some of the factors that affect readability, in particular, ability to decode print, and on the other hand, it introduces additional factors, notably the ability of the speaker to "deliver" the message, and the rate of presentation.

An examination of the meager evidence assembled to date forces one to conclude that the application of standard readability formulas to prose destined for oral presentation is risky at best. Nevertheless, all the studies examined, that seemed to be relevant to the problem, do show positive relationships; positive relationships are exhibited at all age levels. At the elementary school level, Rogers (1952) was able to make a valid modification of the Dale-Chall formula. In a careful study using 6th-graders, Allen (1952) found that when the Flesch Readability Index and Human Interest measures were used to contrive spoken film commentaries, the Readability Index correlated positively with pupil gain from pretest to posttest on each of two films, and the Human Interest measure did for one of them. Sentence length was the most important factor. However, the design of Allen's experiment also suggests that another factor was operating, namely the extent to which the commentary followed a "patterned outline." Harwood's (1955) experiment, conducted at the 10th grade level, showed clear correlations between Flesch readability indices for seven short stories and pupil's ability to answer questions on them when presented auditorily. The pattern of results for these same paragraphs presented in printed form was highly similar, except that for some of the more difficult paragraphs the comprehension scores for listening were somewhat lower.

Evidence at the college level is more meager. Chall and Dial (1948) found that the Dale-Chall formula applied to radio news broadcasts tended to correlate with students' ratings of understandability and comprehension, but the effect was noticeable only at the extremes, i.e., for very easy and interesting broadcasts as contrasted to very difficult ones. Beighley (1952, 1954) in a careful study of various speaker and presentation factors found that comprehension scores for an "easy" speech were in most cases significantly different from those for a "hard" speech; the speeches had substantially different ratings by the Dale-Chall formula, but were also differentiated in terms of their ratios of abstract to concrete material. Manion (1953) found no validity for any of the elements in Flesch, Lorge, and Dale-Chall formulas in predicting ratings of "understandability" of a spontaneous group discussion by the participants therein; it is doubtful, however, that spontaneous speech that would occur in a discussion would exhibit the characteristics of formal speech prepared in advance, and Manion's results therefore have questionable applicability.

Interest in measuring "listenability" of longer discourse seems to have declined since the 1950's. To date there seems to have been little attempt to apply any of the newer methods, such as the cloze technique, for this purpose. (Subsequent sections, however, will report a number of studies using the cloze technique, rote memorization scores, and various stylistic indices to appraise the comprehensibility of shorter discourse such as single sentences.)

It would be desirable to establish baselines for the comprehensibility of verbal material presented orally (thus, without the intruding variable of reading ability), for comparison with data on the readability of the material when presented in printed form. The small experiment by

Harwood (1955) is the only one that attempted to make such comparisons; it should be repeated on a large scale, at different grade levels, with more adequate samples, and with a greater variety of comprehensibility indices.

Recently, a series of experiments on variables affecting the communicative effectiveness of teachers' lectures has been performed under the direction of Gage (1968). It has been demonstrated that teachers differ consistently in ability to give information lectures as judged by pupil gain scores on comprehension tests. While traditional measures such as vocabulary load and sentence complexity have little or no validity in predicting gain scores, there is evidence (Rosenshine, in press) that measures of such factors as "vagueness" (indexed by overuse of such words as very, pretty, some, maybe, etc.), "explaining links" (skillful use of such words as therefore, because, etc.) and use of examples will yield valid predictions. This line of research is promising and important.

Source-of-Message Characteristics

Petrie (1963) states:

"Although a considerable amount of experimental evidence indicates that source credibility influences opinion change... there is little experimental support for the assumption that source credibility or source sincerity influences the amount of information learned and retained from an informative speech. Although Kelman and Hovland ... report that high school students were able to recall persuasive material more readily when it was presented by a 'neutral' source rather than by

one which was 'negative' or 'positive,' most investigators report that source credibility, source sincerity, and the audience's like or dislike for the speaker have no effect upon the listener's comprehension of the message."

Vocabulary Load as a Message Characteristic

It is commonly recognized that one of the factors making a test easy or difficult to understand is its vocabulary load. Numerous studies conducted in the earlier years of the present century drew attention to the role of vocabulary load in creating difficulties in pupils' comprehension in literature (Irion, 1925), in social studies (Dewey, 1935a, 1935b), in science (Curtis, 1938), and other subjects. There has been much concern with developing lists of words graded in difficulty for various educational levels, usually based on frequency counts (Buckingham and Dolch, 1936; Rinsland, 1945; Thorndike and Lorge, 1944).

Measurements of vocabulary load have figured prominently in readability formulas. According to Klare (1968), "Of the 31 formulas published up to 1960, 17 use a word-count factor directly and most others a related factor (e.g., word length)." For example, the formula he regards as most accurate, the Dale-Chall formula, contains a factor based on the percentage of words that are not included in the Dale list of the 3000 words found to be known by at least 80 percent of 4th graders. In the 376 passages in Books II to V of the McCall-Crabbs (1926) test lessons, the mean percentage of such words was 8.1011 with a standard deviation of 6.3056. (The distribution must have been considerably skewed, positively.) This had the highest

correlation, .6833, with the criterion, the reading-grade score of a pupil who could answer one-half the test questions correctly. It may be noted that the Dale list is based not on frequency but on familiarity. Certain words such as bracelet, watermelon, and cabbage appear on the Dale list despite having low frequencies in the Thorndike-Lorge list.

Elley (1969) has developed a promising method for assessing readability solely on the basis of weights for noun frequencies.

Vocabulary load has also been shown to be a factor in the comprehension of spoken material. For example, Yoakam (1947) gave tests involving three versions of a radio news story to groups of high school pupils. Comprehension, as measured by a test that was the same for all groups, was easiest when the difficulty of vocabulary was low.

Furthermore, vocabulary difficulty has been shown to play some role in learning. Hall (1954) had college students try to recall random lists of 20 words after serial presentation at the rate of 5 seconds per word. Mean recall for lists containing words of 1-per-million frequency (by Thorndike-Lorge counts) was 12.04; for word lists with 10-per-million frequency, the mean was 13.31, and for word lists with 30-per-million frequency, 15.02, all differences being significant. However, Tulving and Patkau (1962) found that while word frequency played a significant part in such free recall, it did not when the results were scored in terms of "adopted chunks," i.e., sequences of responses that preserved the order in which they stood in the original presentation. Word frequency was nevertheless related, in this study, to the mean size of the "chunks" adopted. Studies exploring various other details of the role of word frequency in verbal learning are by

Sumby (1963), Lloyd (1964), Winnick and Kressel (1965), and Follettie and Wesemann (1967). Without going into the details of these studies, one may conclude that the role of word-frequency is not simple. It would appear that the mere frequency of a word in large word-counts is not the crucial variable. Sumby suggested that there is a tendency for high-frequency words to be associated and learned on a semantic basis, while low-frequency words are associated on a phonetic basis. Winnick and Kressel's results turned up the fascinating finding that frequency is highly correlated with meaningfulness and learnability for "concrete" words, but the correlation is insignificant for "abstract" words. Darley, Sherman, and Siegel (1959), Gorman (1961), Spreen and Schulz (1966), and Paivio (1969) have developed methods for scaling the abstract-concrete dimension of words. "Concreteness" appears to favor learning when the task requires production of the responses. It also favors recognition, according to Gorman's results, but frequency operates in the other direction. Both Gorman and also Shepard (1967) found that subjects are better able to recognize rare words as being previously presented; apparently such words make a greater impression on the subjects when first presented, or are less likely to be confused with other words.

With Anisfeld and Lambert's (1966) finding that "pleasant" words are learned faster only when they are response-terms in nonsense-syllable-word pairs, the several variables considered here (frequency, abstractness-concreteness, and pleasantness, along with the type of learning task involved) are seen to have fairly complex relations that have not yet been adequately investigated. Exactly what implications

these findings have for the learnability of prose materials as a function of the characteristics of the words contained in them is not clear. However, most of the experiments have been conducted using college students who could be expected to know most of the words involved. Different results might be obtained if the experiments were conducted with elementary school or high school students with lower average vocabulary levels. To put the matter in another light, experiments on learning, when the independent variables are characteristics of the words to be learned, must take into account the degree of comprehension of the words on the part of the subjects.

The role of words in making a text easy or difficult to understand is actually a very complicated matter:

(1) Many words have multiple meanings and multiple grammatical usages. The simple word <u>like</u> can be used as a noun, a verb, an adjective, a preposition, a conjunction, an adverb, and a suffix, in various senses. This is the general phenomenon of homonymy. In spoken English, different words that have the same sound, as <u>meet</u> and <u>meat</u>, are called homophones; in printed English, different words that have the same spelling, as <u>row</u> ("array," or "to propel a boat") and <u>row</u> ("quarrel") are called homographs. Frequency lists rarely take account of these multiple meanings and grammatical usages. It is possible, therefore, that even when a text contains words of apparently "high" frequency, the particular usages of those words may be of low frequency and hence may present considerable difficulty for comprehension. This matter has not been investigated systematically, but representative researches touching on it are by Howards (1964), Ammon and Graves (1969), and MacGinitie (1969).

(2) Students differ enormously in their vocabulary knowledge. A word may be totally familiar to one student, totally unknown to another, and known only in a different sense-meaning to a third. A fourth student may be able to infer the meaning of the word from the context. The effect of vocabulary knowledge also may vary depending upon whether the presentation is oral or written: for young children, listening vocabularies are larger than reading vocabularies, while for educated adults, reading vocabularies may actually be slightly larger than listening vocabularies. Research on student differences in vocabulary knowledge will be reviewed in Chapter 8. At this point in our review we can only say that we need more information concerning the "grade placement" of words. Some of the word lists previously cited (Buckingham and Dolch, 1936; Rinsland, 1945) attempt to place words by grade level, but these lists extend only to the upper elementary grades. Dale and Eicholz (undated) issued around 1960 a preliminary report of their research designed to produce lists for grades 4, 6, 8, 10, and 12. Diederich and Palmer (1956) reported the difficulty in grades 11 and 13 of 4,800 words from 6,000 through 20,000 in frequency-rank according to the Thorndike lists. Unfortunately, these lists are not organized and integrated in such a way as to permit convenient use. Even Thorndike and Lorge's (1944) frequency list is organized in three separate alphabets--one for the 19,440 most common words and two for 10,560 other, less common words. Thorndike and Lorge suggest grade levels for the several frequency ranges, without citing any research basis for their suggestions. It should be borne in mind that word frequency is not a sure guide to word difficulty (Gates,

Bond, and Russell, 1938.) There are many low frequency words that are quite familiar to children, and yet some of the senses of high frequency words are unfamiliar even to persons at advanced educational levels. Furthermore, as Serra (1954) has warned, the mere simplification of vocabulary will not necessarily promote comprehension when the concepts being presented by a text are inherently difficult.

Because of the limitation in scope announced in Chapter 1, we have not considered here the problem of difficulties of word perception either in auditory or visual presentation. For a review of work on speech intelligibility, see Black (1961b). Traul and Black (1965) showed that increasing word context aids word identification in aural perception. Klare (1968) has reviewed studies relating word frequency to tachistoscopic perception.

Syntactic Factors in Text Difficulty

Some remarks on this matter have already been made in Chapter 2 (pp. 44-49). A brief but more analytic treatment is given here.

Length of sentence or material. Length of sentence is a frequent factor in readability formulas. MacGinitie and Tretiak (1969) found mean sentence length a better predictor of readability than a measure of grammatical depth (see below). Follettie and Wesemann (1967), Martin and Roberts (1967), and Epstein and Arlinsky (1965) found length of sentence or paragraph to be a significant factor in ability of subjects to memorize or recall the material. However, as was demonstrated by Schlesinger (1966b), length of sentence is not an important variable as such when other factors are controlled, namely,

the grammatical construction of the sentence. This finding pertained to the sentence level. There has been little research beyond that of Lyon (1917) on the influence of length on the learning of prose material; see Frase (1967).

Grammatical structure. Recent psycholinguistic research, inspired mainly by the work of Chomsky (1957, 1965, 1967), has concentrated its efforts on determining the role of grammatical structure in the comprehension and learning of sentences.

Phrase-structure constituents. Many techniques have been employed to demonstrate that sentences are perceived in terms of phrase-structure constituents. Huttenlocher (1964) showed that at early ages children have difficulty, in fact, in perceiving separate words as constituents of phrases. The most cogent work on this problem has been done by N. F. Johnson (1965) and Martin (1970). The "click" experiment (Bever, 1968; Scholes, 1969), the "probe technique" (Ammon, 1968, 1969), and the eye-voice-span technique (Schlesinger, 1966b) are also useful. Suci (1967) and Suci and Gruenfeld (1969) have investigated the role of pauses. Wilson (1966) showed little effect of phrase structure for memory functions in young children.

Grammaticalness. Artificial materials can be constructed with various degrees of conformity with presumed grammatical and semantic rules of the language. There is generally a high degree of agreement as to how "grammatical" a sentence is (Coleman, 1965b; Danks, 1969a, 1969b; Danks and Lewis, 1970; Downey and Hakes, 1968; Stolz, 1969; Tikofsky and Reiff, 1967; Tikofsky, Reiff, Tikofsky, Oakes, Glazer, and McInish, 1967), but under certain circumstances this is not necessarily the case (Maclay and Sleator, 1960; Quirk and Svartvik, 1966).

Syntactic anomaly. Detailed studies of the relation between grammaticalness and ease of learning have been focused on the variable of syntax. Significant positive relations have been found by Coleman (1965a, 1965b), Epstein (1961, 1962), Johnson (1968a), Marks and Miller (1964), Martin, Davidson, and Williams (1965), and Wang (1970). Lezotte and Byers (1968) found a perturbation in this relationship in that semi-grammatical sentences were less well learned than sentences totally lacking in grammaticalness. Miller (1962a) found that grammaticality was positively correlated with intelligibility in noise. Rohwer, Shuell, and Levin (1966) found that noun pairs were better learned when they were inserted in simple declarative sentence frames than when they were simply connected by conjunctions. Salzinger and Eckerman (1967) found a positive relationship but pointed out that frequency effects could explain the results as well as grammatical theory; this type of explanation was also proposed by Goldman-Eisler and Cohen (1970). Fillenbaum (1970) gave several reasons for cautioning against the use of memorial techniques to assess the comprehension of syntax. Salzinger, Salzinger, and Hobson (1966, 1967) used various degrees of syntactic anomaly in testing linguistic abilities of middle-class and disadvantaged children.

Semantic anomaly. Grammaticalness can also be studied by holding syntax constant but varying semantic features and subcategorization rules. Davidson (1966) and Stolz (1969) found learning correlated with grammaticality as expected; Downey and Hakes (1968) did not. Apparently the critical factor is the method of measuring learning.

The relative roles of syntax and semantics. This raises difficult theoretical and experimental problems. In general, as Schlesinger (1966b)

points out, "complete separability of syntax and semantics is an untenable proposition." One experimental approach has been through the study of what has been called the "footnote hypothesis," i.e., the notion that the basic meaning of a sentence is paramount but that the syntactic form of a sentence is remembered as a kind of "footnote." Positive evidence for this hypothesis has been found by Miller (1962b), Mehler (1963, 1968a), and Morris, Rankine, and Reber (1968). However, Rosenberg (1968b) showed that when only one type of syntactical structure has to be remembered, syntactic complexity is not related to recall. Bregman and Strasberg (1968) also present negative evidence. Nevertheless, the work of Sachs (1966, 1967a, 1967b) shows that the syntactic form of a sentence is forgotten very rapidly in comparison to forgetting of its semantic content.

If one is thinking only of comprehensibility, Hamilton and Deese (1970) claim that grammaticality is more important than semantics. Mehler and Carey (1967, 1968) show that changes in surface structure have a stronger effect than changes in base structure, and that syntax interacts with veracity.

Grammatical complexity. Efforts have been made to measure the overall grammatical complexity of a sentence and relate this to comprehensibility and to recall. Theory provided by Yngve (1960) has been utilized for this purpose by Bormuth (1964a), Brown (1967), Forster (1967), MacGinitie and Tretiak (1969), Martin (in press), Martin and Roberts (1966), Nurss (1967), Perfetti (1969), and Wearing (1970), but with somewhat conflicting results. For example, Bormuth finds "mean word depth" a better predictor of comprehension difficulty

than sentence length, whereas MacGinitie and Tretiak find the opposite. Wearing found sentences with low mean depth better remembered than sentences with high mean depth, whereas Perfetti found that depth had no influence. Nurss found that syntactical structure indexed by depth affects reading difficulty when measured by oral reading errors, but not when measured by a picture comprehension test.

Foppa and Wettler (1967), working with the German language, found the predictability of sentences best when the syntax was complicated. Martin and Jones (1965) found that highly redundant (i.e., predictable) phrases were learned faster than phrases with low redundancy.

Order of approximation to natural language. An approach to controlling the net complexity--both syntactic and semantic--of a sentence for experimental purposes was originated by Miller and Selfridge (1950). They artificially constructed sequences of words with various degrees of statistical approximation to English and showed that the higher the degree of approximation, the better remembered these sequences were. Various issues raised by this research have been investigated by M. Brown (1966), Herrmann (1962), Knox and Wolf (1965), Lachman, Dumas, and Guzy (1966), Lachman and Tuttle (1965), Lawson (1961), Pike (1969), Richardson and Voss (1960), Sharp (1958), Salzinger, Portnoy, and Feldman (1962), and Tejirian (1968). For example, Tejirian's results seem to indicate that syntax is the more important factor with low orders of approximation, while semantic factors are more important with high orders of approximation. Brown's and Herrmann's results seem to disagree with respect to the role of word frequency and familiarity; in the usual method of constructing

orders of approximation, word familiarity and the familiarity of grammatical sequences both tend to increase with order of approximation and thus constitute confounding influences.

Similarity to oral language patterns. Ruddell (1964) obtained results showing rather clearly that children's performance in reading comprehension is partly a function of the extent to which the syntactic patterns in reading material are similar to the patterns in their oral speech, even when vocabulary difficulty is controlled. This result lends further support to the notion that variations in the comprehension of different syntactical phenomena are to be explained in terms of the frequency and familiarity of those patterns.

Ambiguity. Carey, Mehler, and Bever (1970), Chai (1967), Foss, Bever, and Silver (1968), MacKay (1966), and MacKay and Bever (1967) have studied the role of grammatical ambiguity in sentence comprehension. When ambiguous sentences are presented in isolation, comprehension is slowed even when the subject is not aware of the ambiguity. On the other hand, if syntactic expectations are built up, the ambiguity is not perceived and comprehension is not slowed. In normal discourse, it is probably the case that grammatical ambiguity has little or no influence except in extreme cases where the writer has failed to provide sufficient context for disambiguation. This topic deserves further study.

Lexical density. Follettie and Wesemann (1967) and Perfetti (1969) have studied the influence of "lexical density" (the ratio of content words to total words in a sentence or paragraph) to comprehension and recall, with results generally favoring the hypothesis that lexical density makes for more difficulty in comprehension and

recall. Their results are not completely clear, however, and this topic also merits further examination.

The role of different types of grammatical units. If lexical density is a significant factor, it is implied that content words carry more information than function words. Several studies have examined the roles of particular types of lexical units. Louthan (1965) and Weaver and Bickley (1968) show that nouns, verbs, and adjectives, in that order, carry decreasing amounts of information. Other studies suggesting that nouns are the ones best remembered are those of Anderson and Byers (1968), Martin (1968), Martin, Roberts, and Collins (1968), and Martin and Walter (1969). Prentice (1966) found that sentences beginning with high response-strength nouns were easier to learn than sentences ending with those nouns. But even grammatical endings and function words carry information (as one might expect) as compared with a situation where they are absent, as Bogartz and Arlinsky (1966) demonstrated.

The role of elementary sentence transformations. There is a large literature, reviewed by Bever (1968), on whether sentences appearing in certain transformations (passive, negative, question) are harder to understand and remember than sentences appearing in the simple declarative form. During the early 1960's, psycholinguists were exploring the hypothesis of "derivational complexity" whereby it was proposed that people understand sentences by "detransforming" them to their bases structures, and that difficulty in understanding was a function of the amount of detransformation involved. Clifton (1965), Clifton, Kurcz, and Jenkins (1965), and Clifton and Odom (1966)

established that perceptions of sentence similarities were those predicted by transformational grammar, but those findings were really irrelevant to the hypothesis of derivational complexity. Representative studies supporting the hypothesis of derivational complexity were those of Miller (1962b), Epstein (1967), Gough (1965, 1966), and Halamandaris (1968). Schlesinger (1966b) felt that his evidence was equivocal, in view of the difficulty of controlling extraneous factors such as sentence length. Slobin (1963, 1966) and Turner and Rommetveit (1967) are among investigators pointing out that much depends upon the inherent semantic properties of the stimuli, e.g., whether the subject and object are transposable ("reversible"). Wearing (1970) found no difference in retention of active and passive sentences. Wright (1969) noted that when a subject is required to answer a question based on a statement that has been presented immediately preceding the question, the latency of the answer depends on whether the statement and question are in the same (active or passive) voice; latency is longer when they are different. This result argues against early versions of transformational theory, but its interpretation in terms of current grammatical theory is a matter too complex for discussion here. One hypothesis concerning the relative difficulty of the active and passive voices, proposed by Greenough and Semmel (1969) and by Goldman-Eisler and Cohen (1970) is that active sentences are easier simply because, being more frequent in speech and writing, they are more familiar.

Evidence that appeared to support the idea of derivational complexity in comprehension was provided by Savin and Perchonock (1965), who claimed that passives, negatives, and questions took more space in

memory than simple active sentences. Several later experiments, e.g., those of Epstein (1969) and Simison (1969), suggest that Savin and Perchonock's results were an artifact resulting from difficulties in recall rather than comprehension.

Subject-object relationships. Much of the evidence on this whole matter suggests that through learning and familiarity, people come to expect that the first noun-phrase in a sentence will be an active subject, and that a later noun-phrase will be the object of an active verb. This expectation constitutes a kind of "heuristic" in sentence comprehension (Bever, 1968); the passive construction, on the other hand, is a signal that this heuristic will not work in a given case, with the result that comprehension is somewhat retarded. Evidence that hearers tend to seek out these subject-object relationships is provided by Blumenthal (1967), Blumenthal and Boakes (1967), Clark (1969), Clark and Begun (1968), Huttenlocher, Eisenberg and Strauss (1968), and Huttenlocher and Strauss (1968), although it should be cautioned that these writers disagree as to the interpretation of their data. On the other hand, when people are asked to rate the "importance" of various elements in a sentence, they tend to choose the grammatical subject as most important, regardless of the construction of the sentence (Johnson, M. G., 1967; Segal and Martin, 1966). This appears to support the idea that the grammatical subject is regarded as the "topic" and the predicate as a "comment."

Other specific grammatical phenomena. There are a large number of studies, concerned with the roles of various specific phenomena in grammar, which merit a listing by author:

(1) Phenomena of negation and veracity: Huttenlocher, Higgins, Milligan, and Kauffman (1970); Jones (1966); Wason (1961, 1965).

(2) Morphology: Bogartz and Arlinsky (1966); Bryk and O'Connell (1967); Martin, Davidson, and Williams (1965).

(3) Mass vs. count nouns: Hatch (1969).

(4) Verb structure: Fodor, Garrett, and Bever (1968).

(5) Verb tense and other markers of temporal relations: Clark and Clark (1968); Clark and Stafford (1969); Smith and McMahon (1970).

(6) Comparative adjectives: Clark (1969); Clark and Card (1969).

(7) Connectives and conjunctions: Katz and Brent (1968); Robertson (1966, 1970).

(8) Embeddings of sentences into other sentences: Hamilton and Deese (1970); Miller and Isard (1964); Schlesinger (1966b); Van Kekerix (1968); Marks (1967).

(9) Relative clauses: Edwards (1969).

(10) Nominalizations: Coleman (1964a); Epstein (1967).

(11) Anaphora and intersentence relations: Bormuth, Manning, Carr, and Pearson (1970). (This important study also contains much information on school-age children's difficulties with a wide variety of grammatical phenomena.)

Factors of Content, Organization, and Rhetoric in Message Comprehension and Learning

Content factors. Although "content analysis" is a well-recognized technique for the analysis of the propaganda value of messages or the

"themes" inherent in discourses, to my knowledge it has not been applied to the analysis of educational materials with respect to their relative comprehensibility. A priori, it has been considered that content interacts with the hearer/reader's background of knowledge; a piece of discourse will be relatively easier for an individual who already has some familiarity with the content. Few studies of this assumption are to be found, however. Ausubel and Fitzgerald (1962) found that general background knowledge in endocrinology facilitated the learning and retention of new material in this field, yet a somewhat similar study by Ausubel and Youssef (1966) tended to disconfirm the notion that previous background helps. Mills (1968), Mills and Nicolas-Famourakis (1966), and Mills and Winocur (1969a) experimented with the effects of rated "meaningfulness" of sentences (possibly a function of familiarity and background) but preferred to ascribe the effects to factors of associative strength (see below).

There are few studies, also, of exactly what kind of content is best learned and remembered. In a previous section we have seen that nouns are found to be best remembered, followed by verbs. Gomulicki (1956) found that subjects remembered narrative sequences better than merely descriptive material; in fact, descriptive material was often transformed, in recall, into quasi-narrative form. Subjects evidently have a strategy of reading or listening such that they scan for the more "important" ideas. And even of these ideas they are more likely to remember those parts that are "topic" rather than "comment." R. E. Johnson (1970) found that rated "structural importance" of elements of a prose passage was related to degree of recall.

Associations among concepts in a text. It has repeatedly been demonstrated that if the words in a text are characterized by having many high-strength interassociations, the text is more easily learned (Riegel and Feldman, 1967; Sheldon Rosenberg, 1965, 1966a, 1966b, 1966c, 1967a, 1967b, 1967c, 1967d, 1968a, 1968c, 1968d, 1968e, 1969, in press; Van Every and Rosenberg, 1969).

Correlatively, it has been demonstrated that as an individual learns a subject-matter better, he has better-formed associations among the concepts (Gardner and Johnson, 1967; P. E. Johnson, 1967a, 1967b, 1969, and in press; Rothkopf and Thurner, 1970; Caplan, 1968; Krueger, 1968).

The converse of these propositions is that incorrect or inappropriate word associations can interfere with comprehension (Hinze, 1961).

Concreteness and imagery. Texts that have many words representing concrete ideas, as opposed to abstract ideas, are more easily comprehended and remembered. Yuille and Paivio (1969) offer evidence that thematic storage is in the form of imagery. This is backed up by considerable research on the role of imagery in recall (Begg and Paivio, 1969; Paivio, 1969; Paivio, Yuille, and Madigan, 1968; Paivio, Yuille, and Rogers, 1969; Pompi and Lachman, 1967).

Yet, Brooks (1965) found that instructions to visualize had little effect on ability to recall a text, whereas accompanying the text with appropriate pictorial representations facilitated recall. Brooks (1967) also claimed that the act of reading suppresses visualization since reading and visualization would constitute two conflicting uses of the same sensory modality.

Organization of textual materials. Since Briggs (1967) has already reviewed evidence on the sequencing of instruction, our consideration of organizational variables will be restricted to characteristics of textual materials and their effect on comprehension and recall.

Lorge (1960) observed that there is no generally agreed-on procedure for measuring the organization of prose; he did, however, propose a method. Beighley (1952, 1954) compared "well organized" and "poorly organized" speeches and found little effect of organization on comprehension as measured by a multiple-choice test. Other studies of the organization of oral materials are by Parker (1962), Darnell (1963), and Thompson (1967).

Lee (1965) developed a method for generating textual materials with various levels of structure or organization; according to him, "the learning effects of level of structure depend upon whether the test is for main parts abstraction, within paragraph detail, or rote; and on the mode of presentation, and part-whole level used."

A theoretical analysis of the effects of organizational variables was presented by El-Okby (1963).

Recently, studies of organizational variables have focused on the detailed manipulation of logical structure (Dawes, 1966; Tweney and Ager, 1969). Frase (1969a, 1969b, 1969c) has shown that the relative emphasis given to concepts and attributes in recall can be manipulated by different types of textual organizations.

Deese and Kaufman (1957) and Epstein (1963) have studied the effect of organization and structure on the temporal factors in recall. Epstein showed that structured material is more rapidly acquired in a forward direction, while unstructured material is more rapidly acquired

in a reverse direction. Frase (1970a) found that inappropriate ordering of sentences impairs memory for relations among sentences more than it does memory for facts given by individual sentences.

Rhetorical and stylistic factors. King and Cofer (1960a) explored the possibility that stories varying in the ratio of adjectives to verbs (the "adjective-verb quotient") would systematically vary in ease of learning and recall; there was meager but suggestive evidence that low AVQ stories are easier to remember. (This would agree with the findings reported earlier that verbs are more likely to be remembered than adjectives.)

Miller (1968), Hiller, Fisher, and Kaess (1969), and Rosenshine (in press) have studied the effect of a stylistic variable called "vagueness" on the effectiveness of teacher's oral expositions. Hiller (1968) showed that vagueness, indexed by the presence of many words conveying indefinite quantity, approximations, probability, and the like, is characteristic of the speech or writing of an individual with low knowledge of a subject. Hiller et al. showed also that teachers whose speech is characteristically vague are less effective in promoting learning in their students when they give 15-minute oral expositions on a topic.

Amplification by expanding wordage might be thought to have desirable effects. Serra (1954), reviewing studies by Wilson (1944) and others, pointed out that amplification does not necessarily produce desirable effects; sometimes it produces only confusion. Purpel (1961), however, found that amplification was effective when the added material consisted of concrete examples of the generalizations presented.

Amplification has some resemblance to the "added parts procedure" studied by Rothkopf (1968c, 1969b). According to him, "In the added parts procedure, new material is gradually added to previous studied portions of a written instructional document until it has been presented in its entirety." Rothkopf found this procedure to be more effective than "comparable whole or part techniques" and offered conjectures as to why it was more efficient.

Serra (1954) also considered the effect of simplification. She felt that simplification, like amplification, could sometimes have deleterious effects on comprehension and learning, especially when essential ideas or concrete examples were omitted. On the other hand, there are situations, as pointed out by Desiderato, Kanner, and Runyon (1956) and Rosenshine (in press), when simplification is effective because it eliminates redundant or unnecessary material.

Rosenshine (in press) observed that teachers who use sequences of oral exposition in which a generalization is presented first, followed by an example, and then a restatement of the generalization, were more likely to produce knowledge in their students.

Context factors. It is commonly observed that meaning is better conveyed when it is provided with appropriate context. Kaplan (1955) experimented with the degree to which precise meanings of particular words can be determined when increased degrees of context are provided. Werner and Kaplan (1950) and Braun-Lamesch (1962) studied the manner in which children can acquire word-meanings through the use of context. Tannenbaum (1955) reviewed a number of experiments showing how a single "index" or "cue" (such as the name of a prominent person, a particular

headline for a news story, or even the simple word "but" in a dialogue) can markedly affect the interpretation of text accompanying the cue.

Context effects in the learning of continuous text have been studied by Bruning (1970), Gagné (1969a), and Gagné and Wiegand (1970). Bruning found certain kinds of relevant contexts helpful; Gagné's studies, on the other hand, suggest that contexts such as superordinate topic sentences have an interfering effect at the time of original learning, but a facilitating effect at the time of recall. Since it is difficult to make sense of these apparently conflicting findings, it is obvious that more study is needed of these matters.

Chapter 5

STIMULUS MODALITY IN LANGUAGE COMPREHENSION

Language occurs in either spoken or written form. Our concern in this chapter is with what factors enter into the choice of these two modalities, either separately or combined, for optimal comprehension and learning. We will also have occasion to consider the extent to which pictorial and graphical representations, appearing either alone or as accompaniments to verbal messages, enhance understanding and learning.

General reviews of the problem

The question of visual vs. auditory presentation of material has been reviewed a number of times (Day and Beach, 1950; Henneman and Long, 1954; Hartman, 1961; Allison, 1964). All these reviews suggest that the matter is an extremely complicated one; research seems to present conflicting evidence on numerous points. Probably the most comprehensive, and most theoretically-oriented review, is that of Travers (1967), who draws on a model proposed by Broadbent (1958) to suggest that auditory and visual modalities constitute separate sensory channels which have to operate independently, and that either channel can become overloaded with information. Thus, Travers believes that combined audiovisual presentations are often less beneficial than presentations through single channels, because combined presentations require rapid alternations of attention and may cause overloading of the separate channels. Travers (1966) conducted a series of studies that in general support this theoretical position; some of these studies relate to the reception of verbal messages. Travers' position, incidentally, is diametrically opposed to the position reached in Day and Beach's review, which claimed that the

studies done up to that time consistently obtained an advantage for simultaneous audio and print channels over either channel alone.

May's reviews of "enhancements and simplifications" of audiovisual presentations (May, 1965a) and of word-picture relationships (May, 1965b) are also relevant to the subject of this chapter. May takes no definite position on the question of whether combined audiovisual presentations are superior to presentations through a single channel, but points emphatically to the need for detailed research.

Before considering comparisons and combinations of channels, we shall take up studies on single channels.

Audition (Listening) as a Channel for Language Comprehension and Learning

Reviews and bibliographies

It is only in the last 15 or 20 years that educators have devoted much attention to listening. Bibliographies and reviews of research are by this time quite extensive (Keller, 1960; Duker, 1964, 1968, 1969; Devine, 1967; Wilkinson, 1970). One has the impression, however, that research in listening has not been sufficiently penetrating and analytical. Much of the research seems to have been intended to establish listening ability as a valid objective for the educational program, without determining its nature and parameters in a precise manner.

Theory of listening behavior

It cannot be said that there exists any comprehensive theory of listening behavior in relation to language behavior in general or to other modes of language reception. Zelko (1954) contributed a semi-popular outline of aspects of listening. Bakan (1956) questioned some

of the assumptions that seemed to be prevalent among teachers of listening: that listening is a unitary skill, that uniform training in listening should be given to all students, that listening skill is teachable, that listening skill is relatively independent of other psychological variables, and that the effectiveness of training in listening can be evaluated by means of a test of listening at the end of the training period.

Listening should be viewed merely as one modality of language reception, affected by all or nearly all the variables that are germane to the other principal mode of language reception, reading. Thus, comprehension by listening is affected by the nature and source of the message, the conditions under which it is presented, and the characteristics of the listener.

Studies of listening behavior

The literature search conducted for the present monograph failed to turn up studies that delineate the parameters of listening behavior (apart from studies of speech intelligibility, which are not considered in this review). Most studies of listening are concerned with comparisons with reading, discussed below, or with measurements of individual differences, treated in Chapter 8. However, Foulke and Sticht (1969) have reviewed a number of studies which focus on listening.

O'Neill (1954) found that many people can make appreciable use of visual cues (by watching lips, presumably) to gain information from speakers, particularly in the presence of interfering noise.

Vision (Reading) as a Channel for Language Comprehension and Learning

The large amount of research on reading, summarized in reviews such as those of Anderson and Dearborn (1952) or Williams (1965), has been concerned mainly with the teaching of the elementary skill of "decoding" print into an analogue of speech, or with accelerating reading rate and similar matters. There has been much less attention paid to the general problem of comprehending language through reading, and to the different kinds of purposes for which reading is done (Hall, 1969). Reading comprehension as a topic in itself has been treated by only a few writers, e.g., Kingston (1961), Mehler (1968b), Pickford (1933), Piekarz (1956), Ryan and Semmel (1969), Schoeller (1950), and Wiener and Cromer (1967).

Studies of reading comprehension

One of the first to study processes of reading comprehension was Thorndike (1917a, 1917b, 1917c), who pointed out that reading is essentially a reasoning process and therefore considered mistakes in reading as being largely errors in thinking. Touton and Berry (1931) analyzed 20,003 errors in comprehension made by college entrants and found that most of them related to inability to understand the details of questions, or to isolate or relate specific elements in the material. Gray (1951) attributed difficulty in reading comprehension to the nature and difficulty of the concepts involved, the way in which they were expressed, or inherent limitations of the reader.

Goodman (1969) and Goodman and Burke (1969) have made refined classifications of oral reading "miscues," i.e., errors in producing spoken responses

to match the text, among children in grades 2, 4, and 6. While many of these miscues are due to failure to recognize words, the majority of them appear to arise from the building up of incorrect expectations about the text. Goodman thinks of reading at this level as a "psycholinguistic guessing game" in which the reader attempts to guess what the text is saying, often by inferring deep structure and producing a surface structure with an incorrect transformation. As Ruddell (1965) has shown, the child is more successful when the language of the text corresponds to his oral language habits.

Studies of reading comprehension processes among high-school-age children are those of Bell (1942) and Jenkinson (1957). At this level, few errors are due to faulty word recognition; some can be attributed to faulty habits whereby the child does not adequately attend to details in the text. Of course, some difficulties stem from inadequate vocabulary knowledge, but most errors are due to faulty thinking and reasoning about the message. Jenkinson provided a detailed classification of the errors children made in attempting to perform the cloze task on a variety of types of literature. Subjects exhibited not only problems in comprehension of materials but also in making appropriate inferences from these materials.

Other useful studies of processes of reading comprehension are those by Bormuth (1970b), Fagan (1969), Macnamara, Feltin, Hew, and Klein (1968), Pickford (1933, 1935), and Swain (1953).

Reading rate. There are few good studies, surprisingly enough, on the parameters of reading rate in relation to difficulty of material, educational level of the reader, and the purpose of reading. Broad generalizations such as the statement that the average college student

reads at 275 words per minute have little meaning. One study that begins to provide adequate parametric information is that by Kershner (1964). Kershner measured reading rates of the adult population by a door-to-door survey, using materials of different levels of difficulty and investigating the effect of requiring the reader to answer questions based on the material.

The possibility that some individuals attain, or can be taught to attain, very high reading rates while preserving comprehension is a highly controversial question. Berger (1968a, 1968b) and Hultgren (1968), after reviewing the evidence, are rather skeptical that abnormally high reading rates can be attained without loss of comprehension. The physiological limit for reading speed "taking in every word" is estimated to be about 800 words per minute. Nevertheless, Schale (1970) renders a preliminary report about two very "gifted" readers who appear to have broken through the physiological limit.

Subvocalization. Edfeldt (1960) reported that degree of subvocalization during reading, as indexed by electromyographic recordings, is related to the difficulty of the material being read. McGuigan, Keller, and Stanton (1964) reported a variety of covert language responses during silent reading but did not relate these either to comprehension or to difficulty of material. On the assumption that subvocalization tends to retard reading speed, Hardyck, Petrinovich, and Ellsworth (1966) developed a conditioning technique whereby such subvocalization could be inhibited. The relevance of subvocalization to reading comprehension has yet to be elucidated.

Eye-voice span. If during oral reading of a passage a reader is suddenly prevented from viewing the material, the number of words he can report ahead of where his view was blocked is a measure of eye-voice span. Several investigators (Lawson, 1961; Levin and Cohn, 1967; Levin and Jones, 1967; Levin and Kaplan, 1966; Levin and Turner, 1966; Wanat and Levin, 1967) have used this technique to investigate the role of various message factors, principally grammatical structure, in reading. Resnick (1970) concluded on the basis of her experiment that syntactic competence is learned independently of perceptual control, but that the latter is necessary for the former. Mehler, Bever, and Carey (1967) concluded from studies of eye-movements that adults acquire the habit of fixating on the first half of phrase structure constituents.

Listening vs. Reading

For a long time, educational psychologists have been trying to answer the question: do people learn best by hearing spoken discourse, by reading printed discourse, or by having some kind of combined experience with hearing and reading?

This is a difficult question to answer even if we exclude problems of the reception of the signal, or of its perception. It is most important to control the time taken for the presentation; the reading and listening abilities of the subjects are also important factors. The method of measuring comprehension and/or recall may give different answers (King, 1968c). In what follows, we summarize the existing knowledge, but it must be recognized that this knowledge is far from definitive.

At the elementary school level, material is usually found to be comprehended and learned better through listening (Carver, 1934, 1941; Caughran, 1953), but W. H. King's (1959) results are not clear on this point. These findings probably reflect the immature reading skills of elementary school pupils. At the high school level and above, however, research results usually favor reading over listening (Beighley, 1952; Carver, 1934, 1941; Caughran, 1953; Cody, 1962; Henneman, 1952; Webb and Wallon, 1956). Corey (1934), comparing learning from lectures with learning from readings, found the latter more effective in terms of immediate recall, but the difference disappeared with time.

In the above studies, little attention was paid to relative presentation times. Webb and Wallon noted that since the time necessary for the read-through of printed material was shorter than that necessary for its oral presentation, reading is a more efficient manner of learning from continuous discourse than hearing it. Webb and Wallon also established that if the time of exposure was held constant, i.e., when readers were allowed to see the material the same amount of time as hearers listened to the oral presentation, they made a significant gain in comprehension.

The superiority of reading print over speech is partly a function of how fast an individual can read. In Chapter 6, we will consider the possibility that more efficient learning from spoken discourse might be obtained if the speech were somehow speeded up.

Probably the best evidence on reading vs. listening available at the present time is that presented by King (1968c) and King and Madill (1968), who used both visual and aural presentations of stories of

several lengths, and both oral and written recalls. The recalls were scored in a number of ways to reveal scores on the two factors of "details" and "gist" that King had previously discovered as important and (relatively) independent dimensions of such recalls. In terms of memory for detailed factual information, visual and auditory modes of presentation are about equal. For "gist" and organized response, visual presentation is superior because subjects have more opportunity (even in equal time with oral presentation) to organize the material cognitively. These results, incidentally, were obtained with college-age subjects.

Little research (except that of Carver, 1941, and Beighley, 1952) has investigated the role of the difficulty (readability, listenability) of the material. Carver's research suggested that the advantage of visual over auditory presentation increases with the difficulty of the material. Beighley's results were equivocal on this point.

However, research with nonprose verbal materials support the idea that visual presentation is increasingly advantageous for more difficult material. Both Schulz and Kasschau (1966) and van Mondfrans and Travers (1964) found that auditory presentation is significantly inferior for materials of high difficulty or low "meaningfulness" such as nonsense syllables or rare words.

Kay (1958) produced evidence that there are individual differences in preference for sensory channel, most people preferring visual presentation for learning word pairs, but a few extreme cases favoring auditory presentation. We do not know whether such preferences also apply to prose materials.

Simultaneous Listening and Reading

For elementary school children, research is available to indicate that, for example, it is advantageous to read aloud test instructions while the child reads along with this presentation. Undoubtedly this is true because of the immature reading skills of many children.

At more advanced educational levels, however, combined auditory-visual presentation of connected prose either shows no advantage over visual presentation (auditory presentation being inferior at this level in any case) or actually constitutes an interference (Mowbray, 1953), particularly if the materials are easy. This is probably because oral presentation tends to be much slower than what is possible in silent reading, and hence the two presentations are, so to speak, out of phase.

Pictorial and Graphic Accompaniments of Verbal Messages

Many aspects of the problem of pictorial enhancements of verbal messages have already been treated by May (1965a, 1965b). Pictures may be of many kinds--schematics, line drawings, up to colored photographs; still or animated. An educational taxonomy of pictures has been proposed by Fleming (1967). The modern film has developed a language of its own; Forsdale and Forsdale (1966) point out how foreign a film representation must seem to preliterate peoples. Jacob (1969), however, claimed on the basis of a research study that the normal child of 11 has mastered cinematographic language "in its entirety."

Words vs. pictures. The research background for this section must be drawn primarily from studies that have involved, not continuous prose,

but single words in conjunction with pictorial representations of those words. Research findings exhibit many inconsistencies that can probably be resolved only with the discovery and testing of the critical variables.

Bourisseau, Davis, and Yamamoto (1965) found that printed words produce more free associations that have "sense-impression" implications than pictures of the corresponding objects. Nevertheless, the proportion of such associations was relatively small. But since pictures are not thought of as useful mainly for producing "sense-impression" free associations, this research of Bourisseau et al. seems of little relevance.

Most researchers find that ideas represented pictorially are more easily learned than ideas represented by single words (Jenkins, Neale, and Deno, 1967; Lieberman and Culpepper, 1965). Rohwer, Lynch, Suzuki, and Levin (1967) found that memory for paired-associates was enhanced when pictures of them showed action (as opposed to still pictures).

Hartman's study of memory for associations between names (printed, spoken) and faces showed no particular advantage for adding the visual dimension, but his experiment has little bearing on the problem because the learning of faces is itself a difficult task (faces probably being much less discriminable than names in either visual or auditory form).

The statement that adults generally have preferences for visual information is supported by Lordahl's (1961) finding that in a concept discrimination task, subjects were more likely to attend to visual than to auditory stimuli. Stevenson and Siegel (1969) found that as children get older, they pay increasing attention to visual information in film presentations, and less attention to the auditory information.

In view of the above research, one might expect to find that pictures do indeed enhance learning when they accompany verbal presentations.

Pictures accompanying connected discourse. The evidence for enhancement from pictures accompanying connected discourse is very meager and certainly inconclusive. Some positive evidence was obtained by Halbert (1943) and Strang (1941), but negative evidence is afforded by the studies of Stutz (1945) and Dwyer (1967), for example. Dwyer found, however, an advantage of abstract, schematic line drawings in the teaching of anatomy, whereas realistic pictures were no better than strictly verbal presentations. Koenke (1968) found that pictures do not help elementary school children derive the main ideas from paragraphs, and W. A. Miller (1938) found that children's understanding of elementary reading material was the same regardless of whether the material had accompanying pictures. Parsons and Frase (1968) reported that college students learn electrical circuitry principles just as well from verbal presentations as they do from graphic presentations. M. D. Vernon (1946) pointed out that students usually do not learn much from graphs. Two studies supporting the advantages of pictorial presentations were those of Williams (1961), who found that students got higher scores on verbal-pictorial tests than on purely verbal tests, and Fredrick (1969), who found students learned grammatical principles better from symbolic representations (tree diagrams of syntactical representations) than from verbal statements.

To conclude pictures sometimes help the conveying of information, but generally they do not. Research is needed to determine what kinds of pictorial presentations enhance the transmission of information, and

under what circumstances. Possibly the critical variable is the method of measuring learning. Surely some pictures convey certain types of information more efficiently than verbal statements, but it is difficult to test the acquisition of this information by purely verbal tests.

Comparisons of Teaching Methods Employing Different Combinations of Audiovisual Techniques

The finding of "no significant difference" between contrasting modes of audiovisual teaching is typical of a vast amount of research conducted in recent years. For example, Dworkin and Holden (1959) found no difference in the effectiveness of lectures and filmstrips for teaching principles of atomic bonding to graduate engineers. Eyestone (1966) found no differences between bulletins, films, and lectures in teaching 4-H club information. It seems useless to review this research in detail not only because significant differences are seldom found but also because the results, obtained in situations where it is generally impossible to control variables precisely, yield little if any insight into processes of comprehension and learning from verbal discourse.

Chapter 6

PRESENTATION FACTORS

This chapter directs attention to a number of variables relating to how a spoken or printed message is presented to the hearer or reader. The effect of these variables on either the comprehension or the learning of the message is considered.

The Presentation of Spoken Messages

The vocal skill of the speaker, and related variables. In the case of informative speaking, Petrie (1963) regards the evidence on the effect of the speaker's vocal skill in delivery as inconclusive. Poor voice, quality, nonfluency, and even stuttering do not interfere significantly with comprehension. Nevertheless, in two separate studies Beighley (1952, 1954) found that students remembered more when they heard a speech given by a skilled speaker. In the second study, this was found to be true both for immediate and delayed (two-week) recall. The effect was more pronounced for hard as opposed to easy material. Coats and Smidchens (1966) found that students had better immediate recall for the contents of a lecture when it was given in a "dynamic" manner rather than a "static" manner. Likewise, T. D. Skinner (1963) found better immediate and delayed recall for a television presentation when given with "good" delivery as opposed to "poor" delivery (an actor was trained to give both types of delivery). One is inclined to conclude that manner of delivery does indeed make a difference, but research has not disclosed any explanation for the phenomenon. Possibly the effect of good delivery is to arouse greater attention.

Rozran (1968) compared the effects of normal and "list" intonation on 4th grade children's comprehension of short informational passages. She found that list intonation appeared to aid the comprehension of difficult passages but impeded the comprehension of easy passages.

Little research has been done on the effect of introducing pauses at phrase or other boundaries in a speech presentation. Bolinger and Gerstman (1957) showed that in the absence of other cues, acoustic pauses are capable of inducing a particular structural (grammatical) organization in speech perception.

Dialect. Harms (1961) found that comprehensibility was greatest when speaker and listener social status coincided. Weener (1969) found that children speaking the standard dialect had trouble understanding a nonstandard dialect, but that children who were speakers of a nonstandard (Negro) dialect understood the standard and nonstandard dialect about equally well. Weener's language samples were 1st, 2nd, and 4th order approximations to English.

Foreign accent. Black and Tolhurst (1955) investigated the intelligibility of English spoken by French and British speakers and the effects of dialect familiarity of American listeners. The French speakers had a reasonably good command of English, but spoke it with an accent. French, British, and American listeners understood British speakers better than they did French speakers. After one hour of familiarization with the foreign dialect, American listeners significantly improved in their understanding of both French and British speakers.

Thus, it would seem that the understanding of dialects and foreign accents is largely a matter of familiarity and learning.

Speech rate. Many investigators (Goldstein, 1940; Diehl, White, and Burk, 1959; E. C. Miller, 1954) have found that over a wide range of oral speaking rates, e.g., from 100 to 200 words per minute, there is little effect of rate on comprehension, learning, or the listener's assessment of the speaker's quality of delivery. With the development of devices for accelerating speech rate without pitch distortion, it has become possible to investigate comprehensibility and learnability of material presented at much faster rates. This literature has been thoroughly reviewed by Foulke and Sticht (1969). It appears that intelligibility is maintained with little change up to about 275 words per minute, although there is a slow decline in comprehension and learnability from about 175 wpm up to that rate. Beyond 275 wpm, both intelligibility and comprehension suffer sharp losses. Foulke and Sticht speculate that this is because speech processing (registration, decoding, and storage) takes time and cannot be efficiently performed at rates above 275 wpm.

Jester (1966; also see Travers, 1966) compared audio, visual, and audiovisual channels with respect to the effect of rate changes on comprehension, controlling time parameters for all three channels in a comparable way. Listening comprehension was found to be slightly superior to reading comprehension up to approximately 200 wpm, but inferior to reading comprehension thereafter. Mean comprehension scores for visual and audiovisual presentations showed a parallel decrease between 200 and 350 wpm, but in terms of efficiency (information gained per unit of time) the decreases were not marked. Simultaneous reading and listening at 350 wpm resulted in better comprehension than could be demonstrated with either mode of presentation alone.

In a special issue of the Journal of Communication devoted to research and theory relating to compressed speech, Barabasz (1968), Foulke (1968), Friedman and Johnson (1968), Miron and Brown (1968), Orr (1968), Reid (1968), Sticht (1968), and Woodcock and Clark (1968) have discussed various issues related to the use of compressed speech in education. See also studies and articles by Barnard (1970), de Hoop (1966), Eckhardt (1970), Enç (1959), Fairbanks, Guttman, and Miron (1957a, 1957b, 1957c), Foulke (1967), Foulke, Amster, Nolan, and Bixler (1962), Friedman and Johnson (1969a, 1969b), Goldhaber (1970), Goldhaber and Weaver (1968), Gordon, Gordon, and Perrier (1967), Gropper (1969), Henry (1967), Langford (1968), Lawton (1967), Loper (1967), Michel-Miller (1970), Orr and Friedman (1967, 1968), Orr, Friedman, and Graae (1969), Orr, Friedman, and Williams (1965), Robins (1968), Rossiter (1970), Sticht (1969, 1970), Voor and Miller (1965), and Wood (1966).

A general conclusion seems to be that after an initial period of adaptation, many students, especially those with above-average verbal abilities, can profitably learn from materials auditorily presented at rates up to 275 wpm. Such presentations are, of course, most beneficial for blind students. Under certain conditions they can profitably be used also with sighted students--for motivation and variety in the educational program, or to aid in the acquisition of reading or listening comprehension skill. Efforts to train people in the comprehension of materials presented auditorily at rates beyond 275 wpm have thus far been essentially fruitless. Also, no effective way of improving the comprehensibility of speech presented at very fast rates has yet been found, but up to 275 wpm variations in intelligibility are affected by such factors as speaker characteristics, method of compression, etc.

Delayed auditory feedback. If a subject is required to read a passage aloud in such a way that a recording of his rendition is fed into his ears with a lag of about one-quarter second, pronounced interference with his speech is produced. This phenomenon is called delayed auditory feedback (DAF), and has been used in a series of researches by King and others to investigate the effect of this type of stress on comprehension, learning, and recall (King, 1963, 1965, 1968a, 1968b, 1969; King and Dodge, 1965; King and Walker, 1965; King and Wolf, 1965; Bernstein, 1962; Harper and King, 1967; Hassig and King, 1968). King (1969) concluded that DAF apparently influences only the learning and not the recall processes. Since DAF uniformly retards learning, these results have no educational application other than to suggest that delayed auditory feedback and similar effects should be avoided.

Distractions during listening. Broadbent (1952a, 1952b, 1956, 1958), Peters (1954a, 1954b), and Treisman (1964), among others, have made extensive investigations of the effect of noise and competing auditory messages on the comprehension of speech. As the competing messages become more similar to the target message, the interference becomes more pronounced. However, because of the characteristics of the auditory channel, Henneman (1952) found that the auditory channel was superior to the visual channel when the subject is required to pay attention to simultaneous messages (e.g., one auditory, one visual) or to perform visual or manual tasks.

Festinger and Maccoby (1964) found that visually distracting stimuli (e.g., films) tend to make people less resistant to auditorily-presented persuasive propaganda that conflicts with their opinions.

The Presentation of Written Messages

Format variables. Research on format variables has had two types of objectives: (1) to investigate psycholinguistic processes, and (2) to test possible methods of improving the presentation of material for informative and educational purposes.

Representative of the first type are studies by Graf and Torrey (1966), Epstein (1967), Anglin and Miller (1968), and Bryk and O'Connell (1967). Graf and Torrey, and Anglin and Miller found that prose material was more easily comprehended or memorized when it was presented in physically separated grammatical units of phrase structure than when the segments were presented in irregular relation to phrase structure. They used this evidence to argue for the "psychological reality" of phrase structure. However, Epstein found that "chunking" the material into phrases by typographical devices did not facilitate learning in the expected way.

Representative of the second type are studies by Hites (1954), Klare, Mabry, and Gustafson (1955b), Klare, Shuford, and Nichols (1958), Hershberger (1964), Hershberger and Terry (1965), and Carver (1970c). Hites found that paragraphing, but not the use of subject headings, was effective in written presentations. Carver's study failed to find any significant usefulness for typographical devices to separate "chunks" or phrase groups in increasing reading speed and comprehension. (Cf. Epstein's result reported above.) The remainder of these studies suggest that only a limited form of typographical "highlighting" of important points (e.g., by underlining or italicizing) is effective in promoting comprehension. More complex types of highlighting (e.g., combined use

of full caps vs. lower case, different colored inks, and underlining) serve only to confuse and distract the reader. These researches, however, have not investigated all the possible types of typographical cueing; for example, it would be interesting to study the effect of outlining formats. It may be that training in the use of these formats would be necessary to make them effective.

Rate. Since reading rate is ordinarily under the control of the reader there has been little research on the effect of controlling reading rate except in the context of training programs for increasing reading rate. In films, it would seem that rates of presentation of printed material vary widely. Reid and MacLennan's (1967) summary of instructional television and film research contains no reference to research on rate of presentation of printed material that would be appropriate for various audiences.

Gilbert (1959) collected useful data on the speed of processing visual stimuli and its relation to reading. Orr (1964) speculated that maximum speeds of listening (to compressed speech) and reading are an index to the speed of "thought."

Distracting stimuli. Reference has already been made to the work of Henneman (1952) which found that requirements to perform visual or manual tasks simultaneously with reading generally interfere with reading comprehension.

Freeburne and Fleischer (1952) showed that presentation of various types of music to groups while reading had no significant effects on comprehension. McGuigan and Rodier (1968) observed that presentation of auditory language stimuli to a subject who is reading produces a greater amount of covert oral behavior, but that white noise does not have this effect.

Chapter 7

VARIABLES IN LEARNING FROM VERBAL DISCOURSE

The previous three chapters have been concerned with factors that could apply equally well to comprehension of verbal discourse and to learning from such discourse. Many of the studies of these factors involved learning simply because learning measures were the most convenient indices of comprehension--indeed, in most cases the only available indices of comprehension. In the present chapter we shall consider variables that apply only to situations which demand that some form of learning from verbal discourse be demonstrated.

Despite the fact that the phenomenon of learning is often considered to be the unique domain of psychology, and despite the long history of psychology's interest in learning, the field still resists satisfactory conceptual organization. This is especially true in the case of learning from verbal discourse, because the traditional categories of learning theory--different types of conditioning, the laws of association, various experimental paradigms--do not seem to be readily applicable. Either the phenomenon of learning from verbal discourse must be regarded as constituting a new and unique paradigm in itself, or it may serve as the basis for achieving a rapprochement among the disparate theories and paradigms of human learning. We would like to believe that the latter is the case, but the fulfilling of any such promise probably lies far in the future.

It would not be easy, for example, to fit meaningful verbal learning within the framework outlined by Gagné (1970). Gagné suggests that all learning can be classified into eight types: signal learning, stimulus-response learning, chaining, verbal association, discrimination learning, concept learning, rule learning, and problem solving. Learning from

verbal discourse might be all of these, or none of these. Conventional treatments of "human learning" (e.g., Hovland, 1951; Hall, 1966; Kausler, 1966; Underwood, 1964) are of little help. Useful analogies between prose learning and list-learning are difficult to draw, although some valiant attempts have been made (Goss, in press; Musgrave and Cohen, in press). There remains a considerable gulf between "verbal learning" research and the analysis of learning from meaningful discourse; nevertheless, it may be helpful in this chapter to utilize some of the kinds of variables traditionally considered in research on human learning, such as frequency and repetition.

The point of view that we would like to espouse here is an "information-processing" view. It is close to the position taken by Ausubel (1968), who believes that meaningful verbal learning involves two processes: perception and cognition. According to him, "perception involves an <u>immediate</u> content of awareness before the intervention of... complex cognitive processes," while "cognition involves such processes as relating the new material to relevant aspects of existing cognitive structure..." (Ausubel, 1968, p. 56).

In the organization of this chapter, we will consider the process of learning from meaningful verbal discourse as a series of events, roughly classifiable into three categories: (a) prelearning events, such as the past learning history of the individual, or events immediately preceding the learning situation, such as the instructions given to an experimental subject or the sets or strategies that the learner brings to the learning task; (b) events during the learning process itself, i.e., during the presentation of the stimulus; and (c) subsequent events, such as the cognitive organization or reorganization of the stimulus material as it is stored in memory or retrieved for recognition or recall.

Prelearning Variables

Meaningful vs. rote learning. For the sake of completeness, and also to clear out some underbrush, we should first mention the question of "meaningful" vs. "rote" (verbatim) learning. It is rare in education, although occasionally justified, that the student is required to learn material verbatim. The more important kind of learning is for the substance or meaning of discourse. Yet a large amount of psychological research in verbal learning, even now, is concerned with the learning of the exact words of a sentence or passage that is presented. Psychologists have long been aware of the difference between meaningful and rote learning (Welborn and English, 1937); their preference for working with the latter has been dictated, for the most part, by the fact that verbatim recalls are much easier to score and quantify.

We call meaningful vs. rote learning a prelearning variable because it is possible to instruct subjects in advance to learn either to retain ideas or to retain the exact words. Cofer (1941) did this and showed that these processes had somewhat different properties: verbatim learning takes more time than meaningful learning ("logical" learning, Cofer called it); time required for verbatim learning increases much more rapidly, as the length or quantity of prose material increases, than is the case for meaningful learning; and there is faster forgetting for verbatim learning. These findings accord generally with those of English, Welborn, and Killian (1934), who invented an ingenious method of measuring both rote learning and logical learning within the same subjects and within the same learning trials. In this latter experiment it may be presumed that some subjects were operating with a set to learn ideas while others were operating with a set to learn words more or less

by rote. Such sets could arise from various sources--a history of success in rote learning, a strategy adopted because of the attitude that rote learning is beneficial, and so forth. Welborn and English (1937) point out that success in meaningful learning is much more related to intelligence (thus, to general verbal ability) than success in rote learning. It is possible that learning for ideas is a strategy much more likely to be adopted by students of above-average verbal ability, while a strategy of learning for rote recall is one more often adopted by students of lower verbal ability.

Since the time of Cofer's classic experiment on logical vs. rote learning, experimenters have paid little attention to this variable except insofar as their experimental designs may be such as to require rote learning. In studies of learning from prose that do not require rote learning, it is still possible that many subjects adopt a strategy that emphasizes rote learning, i.e., the memorization of sequences of words without understanding their meaning. Thus the variable of learner strategy has often been left uncontrolled; possibly this accounts for conflicting results in the literature of learning from prose. Techniques such as that employed by English, Welborn, and Killian (1934) could be used to determine the typical strategy of the subjects.

In one of the few recent studies of the effects of differential learning instructions (King and Russell, 1966), a "rather disturbing conclusion" was suggested:

> "When Ss [undergraduates taking an introductory psychology course] are instructed to learn connected meaningful material on the basis of main ideas or essential ideas they tend to recall proportionately more words, letters, sentences, etc., than ideas or sequences of words. On the other hand, when instructed to learn on an exact wording or a word-for-word basis, Ss recall

> proportionately fewer words, letters, sentences, etc., and more ideas. Apparently, Ss rather consistently interpret instructions in learning connected meaningful material in a manner not in keeping with the expectations of Es. A great deal of research is needed on the interpretation of the learning instructions by Ss and the strategies they adopt to fulfill these instructions" (King and Russell, 1966, p. 482).

It is possible that these results are in some way an artifact of King and Russell's experimental procedures or their methods of scoring recalls. Otherwise, one is tempted to recommend more emphasis on rote memorization in order to promote more meaningful learning!

[An experiment by Elley (1966) contrasts rote and meaningful learning, but his definitions of these terms do not correspond to "rote" and "logical" learning as used here; Elley's tasks did not involve prose learning.]

Intentional vs. incidental learning. This is a matter of whether the learner intends to learn, or at any rate, knows that he will be tested and has some motivation to do well on the test, or, on the other hand, is exposed to the material under the impression that there is no need for him to learn (sometimes under an instruction that directs him to learn or pay attention to some aspect of the material that is irrelevant to what he will eventually be tested on).

It is a matter of common observation, supported by a vast amount of earlier research, that learning from prose is better when it is intentional. Under incidental learning conditions, the learner can easily read or hear a sample of prose without paying attention to its meaning.

Epstein (1967) and Epstein and Arlinsky (1965) found that structured material, i.e., syntactically well-formed sentences, was easier to learn than nonstructured material only when learning was intentional.

Introductory material and "advance organizers." It is the common practice of writers and lecturers to begin their presentations with "introductory remarks" that will help to structure what is to follow; indeed, this very sentence is an instance of this. To what extent does this introductory material aid in learning?

A long series of researches on what Ausubel (1960) calls "advance organizers" is relevant to this question. According to Ausubel, advance organizers are various kinds of introductory expositions which either present new, generalized concepts under which further detailed learning can be subsumed, or draw distinctions that enable the learner to discriminate the new concepts from those he may have established in his previous knowledge. Experimental studies by Ausubel (1960), Ausubel and Fitzgerald (1961a, 1962), Ausubel and Youssef (1963, 1966), Scandura and Wells (1967), Grotelueschen and Sjogren (1968), Proger, Taylor, Mann, Coulson, and Bayuk (1969), and Allen (1970) have generally confirmed these notions. However, the usefulness of advance organizers seems to interact with the degree of previous knowledge of the learner or with his level of verbal ability in complex ways. Furthermore, Bauman and Glass (1969) obtained results suggesting that "organizer material" may be more useful when presented after learning than before it.

Other kinds of prelearning instructions and information. Frase (1969b) found that a paragraph providing a "conceptual structuring" of subsequent learning material improved later recall. Similarly, Merrill and Stolurow (1966) found that presenting Ss with a summary of an imaginary science

prior to learning to solve problems in it did not take increased time but increased the number of correct responses during the learning session and on the test. Christensen and Stordahl (1955) failed to find any effect of organizational aids (summaries, outlines) presented prior to (or within) reading passages, but it is possible that the motivation and attention of their subjects (Air Force recruits) was poor.

Tannenbaum (1955) showed that presentation of certain cues in advance of the reading of a passage had marked effects on the interpretations that the subjects made of these passages. Brooks (1965) found that subjects instructed to visualize a series of spatial relations described by verbal material ("Try to picture how this scene would look") had no effect on their learning. Brooks also found that prior learning experience with visual representations of similar sentences, or viewing of isolated pictures of the objects in the pictures, had no effect either.

Advance inhibitors. If advance "organizers" can have a salutary effect on the learning of meaningful prose, can advance presentation of dissonant, interfering material inhibit learning? This is the general question of "proactive inhibition" which has been widely studied in verbal learning research. Of course, in a very general way, all the individual's previous language habits are likely to interfere with new learning, as is shown by the error analysis of recalls (Cofer, 1943) or in attempted serial reconstructions of approximations to English (Coleman, 1962b).

Proactive interference in rote prose learning has been demonstrated by Slamecka (1961) and Mills and Sacks (1967), among others. Ausubel

and Blake (1958) and Entwisle and Huggins (1964) have demonstrated its operation also in meaningful prose learning, but its effects can be reduced by the careful drawing of distinctions and contrasts so that the learner can reconcile the apparent inconsistencies. Ausubel, Stager, and Gaite (1969) were in fact able to eliminate its effects entirely, even when the interfering material was overlearned.

Wittrock (1963) found that the learning and retention of differences were enhanced by the use of explicit directions to notice the differences.

Questions presented prior to learning. It is frequently the case, in instruction, that teachers or textbook writers pose questions for their students or readers to be alert to find the answers for during subsequent presentation of learning material. What effects do these questions have?

Frase (1968d, 1970b) has reviewed a considerable amount of research on this matter. While pre-questions do have certain positive advantages, they also have the disadvantage that they cause the learner to focus attention on certain aspects of the learning material, and to pay less attention to other aspects that may be equally important. Peeck's (1970) research confirms this generalization. It is usually better to insert questions at certain strategic places within the instruction, or even to present the questions after the instruction (with or without opportunity for review). This matter will be discussed below. Thus far, research has not indicated what the effects of questions presented both before and after instruction will be.

To minimize the disadvantages of pre-questions, it might be thought that highly general types of questions could be used. Nevertheless, Frase (1968b) found a result opposite to this prediction.

On the whole, research suggests that the use of orienting questions be avoided. It is much better to ask the learner to absorb as much as he can from verbal instruction.

Variables Operating During the Learning Process

Length-time relationships. There has been insufficient attention to the parameters of meaningful prose learning with respect to the length of the material and the time required for learning to different criteria by learners of different abilities and with different methods. Lyon (1917) provided data showing that for passages of 1000 words or less (poems), time of learning (presumably by rote) increases approximately linearly with length. Over the range 25 to 150 words, Cofer (1941) also found approximately linear relationships for both verbatim and "logical" (idea) learning, but the slope was much steeper for verbatim learning. It is interesting to note that the linear relationships found for meaningful prose, whether by verbatim or logical methods, are strikingly different from the generally logarithmic length-time relationships found for nonsense material (Hovland, 1951, p. 620-622). That is, additional increments of nonsense material take proportionately more time to learn as the length of the material increases. Evidently the structured, grammatical, semantic aspects of prose material do not have this incremental effect.

King (1970), however, failed to support the total-time hypothesis (that constant amounts are learned in equal amounts of time) with serial learning of connected discourse over the range 10 to 40 words in length. Tulving (1967) suggested that the limit for memory is set by the number of accessible memory units, but not by the contents of those units. He also noted (1964) that while

intertrial learning may increase logarithmically, intratrial learning is a different function and may increase linearly. Length-time relationships for prose learning need much further investigation.

Frequency and repetition. Actually, these are somewhat different concepts or variables. Frequency is probably best applied to the notion of the frequency with which words, concepts, ideas, sentence patterns, etc. have been experienced in the past history of the individual; thus, it corresponds roughly to familiarity. Underwood (1959) and Underwood and Schulz (1960) review evidence that "the frequency with which verbal units have been experienced is the fundamental variable responsible for the characteristics which have been used to define meaningfulness," and suggest that an understanding of the role of frequency (in this sense) is important in shaping the educational endeavor. In the present review we have seen many illustrations of the importance of frequency.

Repetition, on the other hand, is usually applied to the number of times that an individual is exposed to a learning experience in either a classroom or an experimental learning situation. In an experimental situation, it corresponds roughly to the number of "trials" that are given. A large number of the learning experiments reviewed here use multiple trials, and it is practically a universal finding that the more trials there are, the more learning there is (up to a point of diminishing returns). This is reflected in the characteristically negatively accelerated learning curve when amount of learning is plotted against number of trials. Furthermore, retention is a positive function of amount of repetition. This is so general a finding that it is hardly necessary to review the evidence for it; it applies to meaningful prose learning as well as it does to other types of learning. Repetition is almost always involved in studies of length-time relationships discussed above.

Meaningful prose learning does, however, have some special characteristics with respect to repeated exposure. Rothkopf (1968a) found that Ss pacing themselves on repeatedly reading informative passages took less and less time with successive readings. Clark (1940) found that successive reproductions of a passage were increasingly accurate, up to a point, even without reexposing the individual to the original passage. There is an apparent conflict between this result and that of Howe (1970), who found that with repeated weekly presentation and recall of meaningful prose the subjects tended to persist in the errors made early in this series of trials, even though they had repeated opportunity to correct themselves by inspecting the material. Howe feels that his results indicate that there should be an emphasis on the avoidance of errors made early in the learning process.

Reynolds and Glaser (1964) found that various amounts of massed repetition of program frames concerning technical terminology in biology had little effect on learning, particularly as measured in delayed testing. These authors recommend that in programmed instruction, repetitions and reviews should be more widely spaced, since massed repetitions are likely to contribute to monotony. The above results were for materials presented visually to the subject. Jakobovits (1965) found that under intentional learning instructions, successive repetitions of prose presented auditorily gave increasingly higher recall scores; under incidental learning instructions, learning was slower and reached an optimum between 4 and 8 presentations, then declined. The difficulty of the material and the attitude of the learner were also important factors in this experiment.

Other research reports that should be consulted concerning the effects of repetition, reexposure, and review, are those by Ausubel (1966a), Gibson (1965),

Kay (1955), Lachman and Dooling (1967), Rothkopf and Coke (1963, 1966, 1968), Merrill (1965, 1970), Merrill, Barton, and Wood (1970).

Serial effects and order of presentation. Deese and Kaufman (1957) showed that for prose materials, in contrast to unorganized lists, items tend to be emitted in free recall in the order of their presentation. Using the method of stimulated recall, however, Rothkopf (1962) found no significant effect of order of presentation.

Tannenbaum (1954) found that a series of news items occurring in a radio broadcast are recalled in somewhat the same way as unorganized materials, i.e., with the typical bowed serial position curve in which the last items are most likely to be recalled, the first items next most likely, and the middle-position items least likely to be recalled.

Effects of context, organization, and sequencing. A general review of this subject has already been provided by Briggs (1967). Mandler's (1967b) review of the effects of organization on memory is also of some use, although it pertains largely to memory for materials other than prose.

We have already reviewed a number of studies (Merrill and Stolurow, 1966; Christensen and Stordahl, 1955) that yielded somewhat conflicting evidence regarding the usefulness of outlines, summaries and similar organizational cues within a lesson. Northrop's (1952) study of the effectiveness of organizational outlines in films suggested that such outlines are useful for "factual" films, but possibly inhibitory for "ideational" films. All these studies, however, pertain to specific information or commentary about the organization of the material, rather than the actual organization of the learning material itself. In general, the research evidence suggests that the organization of the learning material often has considerable effect on

learning. For example, Eustace (1969) used "learning set analysis" to organize a program for the teaching of a complex concept--that of "noun" --to 2nd and 3rd graders and found that a well-organized program was significantly more effective than one that was not organized according to "learning set analysis."

Gagné (1969a) and Gagné and Wiegand (1970) have studied the effects of putting several kinds of context sentences immediately preceding facts to be remembered. These sentences were "superordinate" (like topic sentences), "coordinate" (conveying a related fact), and "unrelated"; in addition there was an "isolation" condition in which the facts were not accompanied with any kind of context. It was found, first, that having no context whatever promoted most recall, followed by superordinate, coordinate, and unrelated contexts in that order. There were no effects, however, for recognition texts. In the second of these experiments it was found that the effect of the superordinate context was enhanced if it also preceded the recall test question.

Bruning (1970) showed that facts could be better retained, in relatively short-term memory at least, when they were presented in relevant contexts, i.e., with other facts about the same general subject matter. However, the order or organization of the various facts made no significant difference; they could be presented in random order as long as they were on the same general topic. Bruning considered that his findings raise a number of questions about the validity of Ausubel's notions about "organizer" concepts. Apparently the only "organizer" effect found relevant in Bruning's study was the topic itself, which was constant in his relevant contexts but highly varied in the irrelevant contexts.

Questions and other "mathemagenic" activities during learning. There is large research literature, already well reviewed by May (1966), Frase (1968d,

1970b), Anderson (1970), and Rothkopf (1970) concerning the role of various activities that the student can engage in, or be caused to engage in, during learning. Rothkopf (1965a) dubbed these activities "mathemagenic," i.e., "giving rise to learning" (from its Greek etymology). The assumption that underlies this work is that learning is strongly facilitated when the learner is somehow required to search his short-term memory for the answer to some question or problem; this process of searching, it would seem, helps to place the item to be remembered in long-term memory store. The basic idea is not new; it was implicit, for example, in the 1917 research of Gates (see Hovland, 1951, p. 642) that showed that "recitation" (attempts to make active recalls) is far superior to passive review or exposure, and that the student can sometimes profitably spend up to 80% of his time in recitation of this sort. (Gates found that recitation is not as profitable for prose as it is for nonsense material, but it is still useful for prose.) The idea is also implicit in the common observation that one learns a subject best when he tries to teach or write about it.

Only in recent years have educational psychologists seriously turned their attention to research on utilizing this idea in instructional materials and procedures. Instructional materials do not ordinarily make good use of the principle. For example, a book or film usually contains no stimuli that force a student to engage in mathemagenic activities. If he does so at all, it is because, perhaps, he has learned this strategy, or is forced to do so as a result of external circumstances. The promotion of mathemagenic activities on the part of the student should be considered one of the teacher's most important functions.

Rothkopf's (1970) concept of mathemagenic activities is so broad as to include orientation ("getting into the vicinity of instructional objects...") and object acquisition ("selecting and procuring appropriate instructional objects"), but probably the most important class of such activities is what he calls "Class III: Translation and Processing." These include "scanning and systematic eye fixations on the instructional object; translation into internal speech or internal representations,the mental accompaniments of reading; discrimination, segmentation, processing, etc." Translation, segmenting, and processing are stages of progressively greater depth and inaccessibility to external observation, but all three have memorial consequences that "become more complex and enduring as the depth of the actions increases." These Class III mathemagenic activities can be prompted and facilitated in many ways:

(1) Interspersed questions. The effects of appropriately inserted questions have been extensively investigated (Frase, 1968d; Kantor, 1960; Kurtz, Walter, and Brenner, 1950; Hershberger and Terry, 1964; Pyper, 1969; Rothkopf and Bisbicos, 1967). In general, it is found that questions are better placed after the material to which they refer, but this is not always the case (Morasky, 1969; Morasky and Willcox, 1970). The interpretation of the question effect is still unclear; on the one hand, questions may have an arousal effect that influences and improves future learning (Natkin and Stahler, 1969), but they also may have the "backward" effect of maintaining existing reading behaviors (Frase, 1968a; Watts and Anderson, 1970). Different types of questions can have different effects: "high level" analysis and evaluation questions seem to prompt more thorough study and cognitive reorganization, while factual questions influence only attention to facts (Hunkins, 1968). Entwisle, Huggins, and Phelps (1968) stress that questions are useful only when the student is well

prepared to answer them. Rothkopf and Bloom (1970) found that the effectiveness of adjunct questions was increased if they were delivered by a teacher rather than by a programmed text, but Thomas (1966) found no such effect. More research is needed to determine exactly how adjunct questions have their effect; an interesting speculation that may be offered here is that questions are most effective when they not only cause memory search, but also cause some sort of reorganization of memory traces and associations. A better theory concerning the effects of questions would make possible the development of a science of question writing. Bormuth's (1970b) essay on achievement testing is a step in the right direction, based as it is on psycholinguistic theory, but it probably fails to take adequate account of the mental processes involved in memory storage and retrieval.

(2) Constructed responses. In programmed instruction, it has been the practice to advocate, following Skinner (1954), provision whereby the student could fill in completions to sentences. Research, however, has shown that requiring the student to fill in a blank is often not necessary, and even time-consuming. For a time it was believed that "covert responding" was more effective and efficient. It is now believed (Anderson, 1970) that the critical variable has to do with whether the program frame requires the student to perform some kind of memory search or cognitive reorganization. Thus, the research on overt vs. covert responding was often ambiguous because it did not consider the kind of cueing received by the student.

Some of the pertinent literature on this problem is by Hartman, Morrison, and Carlson (1963), Ashbaugh (1964), Goldbeck and Campbell (1962), Cartier (1963a), Coulson and Silberman (1960), Crist (1966), Krumboltz and Weisman (1962), and Williams (1966).

(3) Statements of instructional objectives interspersed in materials: Games, Johnson and Klare (1967).

(4) Spoken responses: Keislar and Stern, 1969b.

(5) Reading under cloze procedure conditions: Anderson, Goldberg and Hidde (1970). Louthan (1965) found that this procedure was most effective when determiners were omitted from the text.

(6) Avoidance of "strong prompts": Anderson and Faust (1967) found that programmed instruction frames making easy copying or identification of correct answers were decidedly less effective than frames avoiding such practices.

(7) Imagery: Anderson and Hidde (1970) found that asking the subject to visualize or image a situation described by a sentence was an effective way of forcing him to process the sentence meaningfully.

(8) Carrying out a physical response. Asher's procedure for requiring the learner to carry out a physical response corresponding to the meaning of a foreign language sentence (Asher, 1966) may perhaps be regarded as a variety of mathemagenic technique.

(9) Guessing and searching for answers: Berlyne (1966) claims, on the basis of his study, that forcing students to guess and then search for the correct answer arouses their curiosity; it may also be regarded as a mathemagenic activity.

It should be mentioned that Carver (1970b) has severely criticized research on mathemagenic effects, on the following grounds: (1) failure to control the total "running time" for the learning (with vs. without questions); (2) failure adequately to control subjects' strategies in dealing with texts and questions; (3) failure to make the research externally valid by making it more comparable to realistic learning situations, e.g., by allowing Ss to look back over reading material when confronted with questions; (4) failure

to relate the results to an adequate theory. Carver's criticisms certainly have some force; many of the points he raises should be made the basis for further experimental investigations. Some of Frase's and Rothkopf's conclusions on the use and placement of questions seem particularly suspect if Carver's criticisms are valid. Nevertheless, it is the judgment of the present writer that the basic notion of "mathemagenic activity" is a useful one, and that it will stand up in further critical tests.

Note-taking during audio presentations. Although note-taking is a widespread practice among students, there is little research that confirms its effectiveness in learning. Cody (1962) found that note-taking was better than merely listening. Minter, Albert, and Powers (1961) found a positive effect only for higher-intelligence and initially-uninterested groups. Ash and Carlton (1951) obtained the result that there was most immediate retention in a group that did not take notes during a film; a group that took notes during the film and reviewed them for 10 minutes afterward retained slightly less, and the group that took notes during the film and was tested immediately afterward retained the least. However, they pointed out that the note-taking probably interfered with learning because the films did not have the pauses and repetitions that would be necessary for note-taking.

Berliner (1969) compared note-taking during a college lecture with several procedures inspired by Rothkopf's "mathemagenic" hypothesis and found it to be less effective than those procedures. Whether Berliner controlled "running time," as Carver (1970b) would suggest, is not clear from his report.

Most of this research seems to fail to take account of the possibility that note-taking is a skill that must be learned to be effective.

Post-Learning Variables

We will now consider a number of "post-learning" variables, such as reinforcement and feedback of knowledge of results, positive and negative transfer effects, and the phenomena of retention as measured by recognition and recall.

It is sometimes difficult to decide whether these effects really occur after learning. Some of these effects can clearly take place during learning trials or sessions. Logically, however, they can best be regarded as post-learning events, if one takes the view that a learning event can occur in a small amount of time and that a learning session actually consists of a series of such discrete learning events. (We might have considered the use of "questions" as a post-learning variable.)

Reinforcement and knowledge of results. It is outside the scope of this review to consider the difficult theoretical issues connected with whether "reinforcement" or "reward" as such has any effect on the kinds of learning that occur during presentation of meaningful discourse. In the first place, rewards or reinforcements are not normally forthcoming during such presentations, unless one regards the acquiring of information as inherently rewarding (as it may be, under certain conditions and for certain people [Jones, Wilkinson, and Braden, 1961, Rosen, Siegelman, and Teeter, 1963]). It is only through various external arrangements (e.g., teachers, use of programmed instruction formats, insertion of questions with answers) that any kinds of rewards or reinforcements accrue to the receiver of written or spoken instruction. Research on the role of reward and reinforcement has necessarily been limited to the study of the effects of such external arrangements. In the second place, it is extremely difficult (some believe it is impossible)

to separate the effects of "reward" or "reinforcement" as such, on the one hand, and of "knowledge of results," on the other. There is an extensive literature on these questions, accessible through standard references on learning and learning theory. Our consideration of these issues will be limited to results obtained in the context of meaningful prose learning, usually in settings such as programmed instruction.

Delay of feedback. According to conventional learning theory feedback and reward are most effective when given as soon as practicable after a response. Evidence is accumulating, however, that this may not be the case with meaningful prose learning. The responses, in this case, are the answers given by students to questions in tests of retention. What is not clear is whether the student should be informed of the correctness of his answers immediately after taking the test (as would be suggested by conventional learning theory), or after some delay. English and Kinzer (1966) and More (1969) have obtained experimental results that indicate that the feedback of information should be delayed to some extent; English and Kinzer found 1-hour and 2-day delays superior to immediate feedback, on the one hand, and also to 1-week delay, on the other. More found optimal delays at 2 1/2 hours and 1-day, as opposed to immediate feedback and 4-day delay. It is difficult to incorporate these results into existing theory, and they may lack external validity in view of the fact that multiple feedbacks, at several intervals of time, might be even more effective. Sturges (1969) inferred from experimental results that feedback should include information concerning incorrect alternatives on a multiple-choice test, but Phye and Baller (1970) were unable to replicate this finding.

Other aspects of reinforcement. Krumboltz and Kiesler (1965) found that partial reinforcement procedures (feedback for only a portion of test questions) made a program less interesting than one with 100% reinforcement and also reduced its effectiveness. However, on a 2-month retention test all differences between groups receiving different degrees of reinforcement during learning disappeared.

Retroactive facilitation and inhibition. These effects are the counterparts of proactive facilitation and inhibition that were discussed as prelearning effects under the headings of "advance organizers" and "advance inhibitors." According to classical verbal learning theory, as a subsequent learning experience becomes more similar to a previous one, there is more and more interference or "retroactive inhibition" (RI) on the retention of the original learning. This has been repeatedly demonstrated with list learning, paired-associate learning, and the like. Nevertheless, according to Hall (1966, pp. 610-612), it has been difficult to demonstrate these effects with meaningful learning.

Among those who have been more or less successful in demonstrating RI in prose learning are Crouse (1970), Entwisle and Huggins (1964), King (1966), King and Cofer (1960b), King and Tanenbaum (1963), Slamecka (1959, 1960a, 1960b, 1962), and Tulving and Osler (1967). Mills and Winocur (1969b) found RI only with low degrees of original learning. Mehler and Miller (1964) used the RI paradigm in an attempt to demonstrate separate learning of syntactic and semantic components of sentences.

Neutral or equivocal evidence for RI was obtained by Ausubel, Robbins, and Blake (1957), Cofer (1955), Gaite, Ausubel, and Stager (1969), Hall (1955), McGeoch and McKinney (1934), Shuell and Hapkiewicz (1969), and Wong (1970).

Evidence for retroactive facilitation, i.e., a benign influence of subsequent learning on retention for the original learning, was obtained by Ausubel, Stager, and Gaite (1968) even when they tried to maximize the amount of interference that would be created by the subsequent learning.

A wide variety of materials and procedures were used in these experiments. Presumably it would be possible to reconcile the apparently conflicting results of these experiments by further experimentation with the several variables that may be affecting the results. Particularly difficult is the problem of controlling or at least assessing the similarities and differences between material for original and subsequent (interpolated) learning. The problem of the similarity paradox may be posed in this connection, as it has been in verbal learning research using nonprose materials: If RI increases as similarity between original and interpolated learning increases, how is it that when similarity is at a maximum (when materials for original and interpolated learning are identical) there is not retroactive inhibition, but rather retroactive facilitation? We can only put this down as a problem requiring further investigation.

Recognition and recall. Recall is the most commonly used procedure in measuring retention of meaningful prose learning; recognition procedures are occasionally used, and relearning even more rarely.

Shepard (1967) found that adult subjects are remarkably accurate in recognizing sentences that they had seen as opposed to sentences they had not seen. After the subject inspected (at this own rate) 612 short sentences (on a wide variety of topics), he was presented with 68 pairs of sentences, each of which contained one "old" sentence (from the 612) and one "new" sentence (not in the 612), and asked to indicate which was the "old" sentence.

Average percent correct was 89%. An almost identical percentage correct was attained by two subjects who had an inspection series of 1224 sentences. (Similar percentages were also found in an experiment involving isolated words.) However, it should be noted that the sentences were in general quite distinct; probably the recognition score would decrease considerably if the inspection sentences were made more similar. (An unpublished experiment recently conducted at the University of Minnesota showed that Ss have much difficulty deciding whether or not they had heard a particular sentence when they had previously heard isolated fragments of the sentence in various combinations.)

Sachs (1966, 1967a, 1967b) has used recognition techniques to demonstrate that memory for syntactic form decays much more rapidly than memory for meaning. Murdock (1963) presented an analysis of the recognition process that postulated that recognition depends upon the number of alternatives available to the subject.

Recall of prose materials on either a verbatim or idea basis has been studied by a number of investigators, e.g., Gomulicki (1956), Cofer (1941, 1943), Rozov (1959), and Tulving and Patkau (1962). These researches show that recall depends partly upon the veridical stimuli in the original material as stored in memory, and partly on what Gomulicki calls an "abstractive" or constructive process that operates primarily at the time of recall. This point has been elaborated on considerably by Bartlett (1932) and Paul (1959). Posner (1963) feels that even at the time of storage, "only in rare instances does S store a pure representation of the stimulus; rather he must be viewed as an active information handler applying his knowledge of the nature of the stimulus and response to reduce his memory load." On the basis of an experiment

in the short-term retention of connected discourse, Pompi and Lachman (1967) are led to think of meanings as being stored as "surrogate structures," i.e., themes, images, schemata, and words. Earhard (1969) attempted to answer the question of whether items are stored as independent units or as interdependent units; she interpreted her results, based on retention of word lists, as favoring the latter. From all the studies of grammatical factors in recall, it seems certain that some grammatical entities are stored at the time of initial exposure, although memory for them may be weaker than for the semantic elements. Tulving and Patkau's (1962) results show rather clearly that the subject stores "adopted chunks" of his own making at the time of original learning.

Cofer (1943) classified errors in recalls of connected prose as errors of (1) word order, (2) omissions, (3) added material or intrusions, and (4) substitution. Roughly the same proportions of these errors were found in both verbatim and logical recalls. A similar analysis of errors in reproductive recalls was made by Rozov (1959), who claimed that "the substitutions cannot be explained in terms of traces or associations but only in terms of the whole process of recall during which the subject can choose indiscriminately any words and expression which appear to the Ss as similar and equivalent."

McNulty (1965), using prose or prose-like materials, attempted to determine whether partial learning accounts for the customarily-found superiority of recognition scores over recall scores; he claimed that it does. Lachman and Field (1965) obtained results which indicate that recognition is superior to recall only at early stages of the learning process.

Where either recognition or recall techniques are used to investigate psycholinguistic phenomena, the same patterns of results emerge, generally. For example, Slamecka (1969) obtained the same pattern of results using recognition procedures, as did Marks and Miller (1964), who used recall, although the parameters were not exactly the same.

Immediate vs. delayed recall. Parametric data on immediate vs. delayed recall for spoken or printed presentations are scarce. In the case of listening, Conboy (1955) found that after a 9-day delay, college students remembered (as measured by a written recall test) only about half as much as they would remember in an immediate recall test, while distortions and intrusions were twice as frequent.

In the case of reading, Thalberg (1967) found that for slow readers, more details are remembered in immediate memory, but that in delayed recall (24 hours) the differences between what is remembered by fast and slow readers largely disappear.

Cohen and Johansson (1967) found that "predictability" or grammatical constraint of sentences had an effect on memory tested immediately, but none on memory tested 20 hours later.

Marks and Jack (1952) present data on the immediate memory span for sentence or sentence-like material as a function of its "order of approximation" to English. The figure obtained for "text" was 15.1 words, but it is not specified what kind of text this is. Also, the method of presentation was unusual, words being uttered at the rate of one per second. Baddeley (1966a, 1966b) studied short-term and long-term memory for word sequences as a function of acoustic, semantic, and formal similarity and suggested that short-term and long-term memory may use different kinds of coding systems.

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A post-learning question: What was the most important point made in this chapter?

Chapter 8

INDIVIDUAL DIFFERENCES IN LANGUAGE COMPREHENSION AND LEARNING

The degree to which an individual comprehends or learns from meaningful discourse is a function of various characteristics of that individual--some relatively stable, others highly changeable. Previous chapters have largely ignored such individual differences, as does much of the literature in experimental psychology and educational research which was considered in those chapters. In this chapter we discuss individual difference variables and their sources, and methods of altering individual characteristics in such a way that improved language comprehension and learning will result.

Major Dimensions of Language Comprehension Ability

Carroll (1968a) has reviewed existing knowledge on the development of native language skills beyond the ages of "primary language acquisition," with respect to the three major aspects of language (phonology, lexicon, and grammar or syntax) and the four major types of language skills (listening, speaking, reading, and writing). Educators have been quite aware that individual differences in vocabulary knowledge and reading comprehension are wide and much of the educational program is designed, in a very general way, to develop vocabulary and reading skills to the maximum possible for the individual. It has not been equally recognized that there may be also large differences in other language skills, e.g., in knowledge of grammatical structures, and in listening comprehension skill. Although normal children at the first grade have a mastery of certain essential grammatical features of their language, their mastery of fine details is far from complete. In particular, they have not

mastered the very large body of lexico-grammatical knowledge that is necessary to understand the sophisticated language of educated adults. This is contrary to the opinions sometimes expressed by writers on the subject. Language understanding depends not only on knowledge of the conventional features of a language system but also upon a large accumulation of general knowledge about the world, its peoples, history, etc. As Kelly (1970) puts it, "a massive dictionary-thesaurus-encyclopedia lies at the heart of human linguistic abilities."

Vocabulary. There are numerous tests, at different levels of difficulty, for measuring individual differences in vocabulary (Buros, 1968), but nearly all of these are normatively scored, and so do not explicitly indicate the size of the examinee's vocabulary, nor the reading (or listening) difficulty level that the individual with a given score could be expected to attain. In spite of the formidable methodological and technical difficulties in developing a criterion-referenced vocabulary test efforts should be renewed in that direction. It is the case, that much of the failure of individuals to understand speech or writing beyond an elementary level is due to deficiency in vocabulary knowledge. It is not merely the knowledge of single words and their meanings that is important, but also the knowledge of the multiple meanings of words and their grammatical functions. Berwick (1952), Howards (1964), and MacGinitie (1969) are among researchers who have been concerned with this problem. MacGinitie found that deaf children are much less flexible than hearing children in dealing with alternative meanings of words.

A number of investigators have tried to compare listening and reading vocabularies (Ames, 1964; Symonds, 1926; Weir, 1951; Armstrong,

1953; Kegler, 1959; Seegers and Seashore, 1949; Yates, 1937; Schultz, 1960; Burton, 1944; Anderson and Fairbanks, 1937). Up to about age 12 or grade 5 or 6, listening vocabulary is greater than reading vocabulary; after that time, reading vocabulary catches up with and begins to exceed listening vocabulary. At the college level, individual differences in listening vocabulary are highly correlated with differences in reading vocabulary (Anderson and Fairbanks, 1937); it should be noticed that even at this level there are wide differences in both reading and listening vocabularies. Yet, both at the sixth-grade (Roy, 1965) and at the college level (Schubert, 1953) vocabulary knowledge does not seem to differentiate good and poor readers--apparently there are factors other than vocabulary knowledge that are crucial. Burton (1944) found that printed vocabulary tests were more revealing than orally-administered vocabulary tests at the 12th grade, however.

Some of the research just cited may seem in conflict with the statement made earlier that deficiencies in vocabulary knowledge account for a large part of the variance in reading difficulty. While further research is needed to resolve this problem, one might speculate that the reading tests on which these conclusions are based do not challenge vocabulary knowlege adequately, either for "good readers" or for "poor readers." As will be seen below, reading comprehension tests measure a variety of skills, of which vocabulary knowledge is only one.

Some efforts have been made to find meaningful correlates of vocabulary knowledge. Blumenfeld (1964) found that a nonverbal pictorial reasoning test was a good predictor of future achievement in vocabulary knowledge, but not in reading skill. Robertson (1967) found that among

10th-graders, certain "verbal fluency tests" share common variance with vocabulary tests that measure "breadth of meaning."

Listening ability. Educators have postulated that indiv duals vary in "listening ability" beyond the mere ability to understand the native language, and a number of tests purporting to measure such an ability--whether it be simple or complex--have been developed (Brown, 1955). The Sequential Tests of Educational Development published by Educational Testing Service include tests of listening ability at four school levels covering the range grade 4 to college age. Wright (1957) constructed and validated a test of listening ability for grades 2 to 4. However, all these tests show substantial correlations with tests of intelligence, educational achievement, and other cognitive abilities. Spearritt (1962) factor-analyzed a battery of 34 tests of listening, reading, and other language skills that had been given to 300 6th-graders. He was able to identify a separate factor of listening ability, but it had substantial correlations with other factors of language knowledge and performance. Freshley and Anderson (1968) also made a factor analytic study of a listening test, the STEP Listening test mentioned above, and found high overlap with subtests of several standardized printed intelligence tests. They did find a number of listening test items that constituted a separate factor, however. Bateman, Frandsen, and Dedmon (1964) factor-analyzed one of the subtests of the Brown-Carlsen Listening Comprehension Test and found that most of the test variance was accounted for by two factors which they tentatively interpreted as "listening for details" and "drawing inferences." These factors are quite similar to factors that also appear in the analysis of reading tests.

A reasonable hypothesis is that a well-constructed listening test could measure overall language comprehension ability; while such a test would correlate fairly highly with reading comprehension tests because of large similarities in content, some part of its variance would remain unique because it would not be subject to variations in the specific reading skills and habits that are measured by reading comprehension tests. Ideally, a listening comprehension test, as a measure of overall language competence would have separate scores for vocabulary knowledge, knowledge of syntactical constructions (or ability to follow increasingly involved constructions), and any other factors that would be useful in the assessment of language skill in the reception mode. Such factors might include, for example, ability to perceive logical organization in discourse material (Knower, 1945; Abrams, 1966) and ability to perceive speech through noise (Castelnovo, Tiedeman, and Skordahl, 1963; Hanley, 1956).

Wilkinson (1965) urges that listening tests be based on realistic conversational material, but although such a test would be useful, it should be accompanied by a test of ability to understand more formal styles of English. It would be desirable, too, to construct a listening test in such a way that the scores would assess ability to listen over a range of speech rates, both slower and faster than normal.

Reading comprehension ability. Buros (1968) has made a convenient compilation of descriptions and reviews of standard reading tests. The measurement of reading comprehension ability is beset with even more theoretical confusion than is the case in the measurement of listening abilities. Those who construct and analyze reading comprehension tests have not clearly differentiated the components of language skills

(vocabulary, grammatical comprehension, decoding skill, inferential behavior, etc.) that need to be measured. Standardized reading tests tap a rather heterogeneous set of skills; these skills differ somewhat from test to test. Even Davis's (1968) careful attempt to isolate factors in reading skill is limited in significance by the fact that the items in the tests he analyzed were not constructed to measure unique skills; rather, each item depends on several skills. Nevertheless, there is evidence in Davis's results for certain identifiable skills such as word knowledge, ability to handle syntax, ability to locate detailed information, and ability to make inferences beyond the data given.

Little has been done, since the study by Blommers and Lindquist (1944), to differentiate power of reading comprehension and rate of reading comprehension. Blommers and Lindquist found, interestingly enough, that there is an important interaction between rate of comprehension and power of comprehension: good readers have high rates on easy material but they slow down on difficult items, whereas poor readers exhibit approximately constant rates regardless of the difficulty of the material.

A further defect of most reading tests is that they are scored normatively rather than with reference to criterion behavior. The typical reading test assigns a "reading grade level" to a student on the basis of his score, but there is seldom any evidence that such reading grade levels mean what they purport to because these reading grade levels are extrapolated from score distributions obtained at given grades. Elley (1970) has described the development of a set of true content-referenced tests of reading, but as yet these tests have

been validated only in New Zealand. The criterion basis for these tests is a set of materials graded in terms of difficulty and cross-referenced to various levels of child and adult reading difficulty.

A start has been made towards the development of an adequate series of criterion-referenced reading tests in this country by Bormuth (1966b, 1967a). Bormuth uses the cloze technique as an overall assessment both of reading difficulty of the material and the individual's ability to comprehend it.

Sources of Individual Differences

Age. Language competence, including the ability to understand speech, develops continuously and in a rather orderly fashion from a very early age. The period from the time of the first utterance up to entrance into the first grade is usually thought of as the stage of "primary language acquisition"; here essential mastery of the phonological, lexical, and grammatical system is attained. There is considerable evidence to support the view that language comprehension ability develops somewhat in advance of language production ability, but it is difficult to trace the development of competence in understanding apart from overt use of language. Representative recent studies of the development of language comprehension are those by Bloom (1968), Bogatyrëva (1967), Flavell (1968), Keeney (1969), Lovell and Dixon (1967), Mehan (1968), Shipley, Smith, and Gleitman (1968), and Slobin and Welsh (1968). Research observations are generally interpreted as suggesting that the child acquires grammar through the meaning system, rather than the other way around.

Development of listening ability undoubtedly extends far into adolescence and even into adulthood, but obviously it initially develops ahead of reading ability. Nesbitt (1969) studied the listening ability of first grade children and concluded that on the average they could understand language ordinarily considered to be of second-grade reading level; 30% of the children could understand language of fifth-grade reading level. Listening abilities of these children correlated significantly with scores on the language sections of the California Mental Maturity Test, but not with scores on the nonlanguage sections.

The STEP Reading and Listening test norms show progressive increases throughout the total range of their applicability (grade 4 to college age); a unique feature of these tests is that scores are on a scale that has an approximately constant meaning throughout its range. It is notable that variability of scores increases throughout this age range; in the reading test, for example, the bottom one percent of college freshman attain scores that are comparable to those made by the median student at about grade 6. Norms of certain vocabulary tests show similar trends.

Some studies have been made of more detailed aspects of language development. For example, Bashaw and Anderson (1968) found that age groups from grade 1 to college show progressively better understanding of the fine differences in meaning among adverbial modifiers such as slightly, somewhat, rather, quite, very, and extremely. Primary grade children could distinguish meanings among only 3 groups of these modifiers while college-age adults distinguished meanings among 6 groups along the scale from slightly to extremely. Peel (1966) studied development of the capacity to reason about text. According to him,

"pupils up to the age of 13-1/2 years judged circumstantially and only by 14+ years did they show a firm tendency to make comprehensive judgments involving the production of possible explanations."

Apparently there is a strong maturational component in the development of language understanding; at any given age, however, language understanding measures correlate highly with other evidences of intellectual development. There is insufficient information on the extent to which maturational development can be accelerated by special training; most research on the training of language abilities shows that training efforts tend to widen individual differences rather than narrow them. Until we know more about the extent to which language understanding abilities can be modified by training, we should not expect average children to understand language far beyond their listening or reading ability levels.

Sex. In the United States, it is a rather universal finding that on the average girls do better than boys on reading tests. Evidence is now accumulating that the opposite is the case for listening tests (Brimer, 1969; Nesbitt, 1969). Brimer (1969) theorizes that in boys, development in syntactic control on the production side is delayed; thus, boys have more pressure to learn to listen, and they do so. Sex differences are also found in performance on verbal learning studies; in King's (1959) study of retroactive inference with the Miller-Selfridge "order of approximation" materials, girls learned more.

Socioeconomic status. In research studies, the term "socioeconomic status" covers a multitude of variables--parents' income, parents' occupation, ethnicity, and even bilingualism. Some lower socioeconomic groups are characterized by learning to speak some nonstandard variety of

English. If understanding of standard English is taken as the dependent variable, the usual finding is that low SES groups do not do as well as "middle-class" children who have learned a more standard variety of English (Chappell, 1968; Garvey and McFarlane, 1970; Osser, Wang, and Zaid, 1969). Garvey and McFarlane mention that both race and social class were important determinants of performance on a sentence repetition task, and Osser, Wang, and Zaid remark that the performance of the middle-class white children was superior to that of their sample of lower-class Negro children even when differences between their dialect and standard English are taken into consideration. The interpretation of these findings is extremely difficult, and certainly not all the data needed for such interpretation are in hand, because of the frequent confounding of race, social class, and dialect differences in these studies. It seems fairly clear that low socioeconomic status is associated with slower language development, with ethnicity and dialect as complicating factors.

Data accumulated by Barritt (1969) and Barritt, Semmel, and Weener (1967) suggest that socioeconomic groups may not differ in basic auditory memory abilities, but that they do differ when standard language patterns are involved in memory performances.

Language performance differences connected with SES differences persist and probably increase up to adulthood. Gentile (1968) found that low SES groups profited little from special instruction in word definitions when attempting to solve verbal analogies items. On the assumption that low SES groups--specifically, low SES Negroes--would have more educational deficits in reading than in listening, Orr and Graham (1968) and Carver (1969) designed a listening comprehension test which would be especially

suited to the dialect, interests and backgrounds of these groups. However, the low-income Negroes showed a deficit on this test comparable to that shown by other standardized measures of aptitude and listening comprehension. Thus, it does not seem to be the case that disadvantagement of this group is specific to reading; it also extends to language in general. This raises the question of how such disadvantagement can be alleviated. Insufficient data are available to answer this question since efforts to study it have a short history.

Filep (1967) obtained some indications that "nonverbal, sound, branching treatments" were particularly appropriate for teaching low IQ, nonwhite, low SES children.

"Intelligence" and cognitive abilities in general. Since "intelligence" is usually measured with instruments that involve much use of language, it is almost tautologous to claim that language development is related to intelligence. For example, the original Binet scale (Binet and Simon, 1908) included sentence memory and vocabulary tests as indices of intellectual development. To a large extent, intellectual development is the same as language development. One cannot deny, however, that there are wide individual differences in language and intellectual development even among groups that have apparently similar learning experiences. We cannot enter into a discussion here of the difficult problems of determining the relative contributions of genetic and environmental factors to these differences.

On the other hand, it should be noted that many varieties of cognitive abilities are distinguishable, and only some of them are closely associated with language development.

Relatively few studies of the language development of mentally retarded children are available. Semmel, Barritt, Bennett, and Perfetti (1967) found significant differences between mental retardates and normal children on a modified cloze test, but these significant differences did not always favor normal children when matching was on mental age.

Special handicaps: Blindness, deafness. Hartlage (1963) found no significant differences between mean listening comprehension scores of blind and sighted students when matched for age, sex and intelligence. Nolan (1962, 1963) has presented a discussion of reading and listening by the blind.

Odom and Blanton (1967) demonstrated that in phrase-learning tasks, deaf children are not able to take advantage of language structure in the same way that hearing subjects do. Rush (1966) described a program whereby substantial success was attained in teaching deaf children syntactical patterns through programmed instruction employing visual memory.

Personality variables. There has been considerable interest in personality variables possibly involved in the remembering of connected discourse. Paul (1959) studied the personality correlates of the tendency to intrude confabulatory material into story reproductions, and a personality factor of this type was also noted by McKenna (1968) in a factor-analytic study of college students' story reproductions. McKenna did not, however, find distinct factors for rote vs. meaningful learning.

Alpert (1955) was unsuccessful in finding any relationship between measures of empathy and reading comprehension of literary and nonliterary measures; if anything, the relationship was negative.

Tobias (1969) found that high-creativity groups learned more than low-creativity groups in programmed instruction on technical subjects.

A study by Neal (1967) found significant relations between certain personality variables and reading performance in a college-age group.

Studies by Runkel (1956) and Salzinger, Hammer, Portnoy, and Polgar (1970) suggest that the success and accuracy of communication between people is partly a function of the extent to which their personality characteristics are similar, and partly a matter of how well they know one another. Maclay and Newman (1960) obtained results indicating that the willingness of an individual to communicate and be understood is inversely correlated with authoritarian attitudes. Possibly such attitudes would operate in determining the willingness of a listener to attend to the details of a message.

In view of the paucity of research on personality variables and language comprehension, this should be a promising field for investigation.

Motivation, Attitude, and Set

Under this heading we consider a series of variables that are important in determining whether a student who is otherwise capable of comprehension and learning will in fact be ready and willing to do so. Reviews of research in motivational variables as they apply in learning from educational media have been prepared by DiVesta (1961), Ugelow (1962), and May (1965a).

Types of motives. Berlyne (1965) emphasizes the necessity of postulating some kind of "arousal" mechanism whereby motives such as curiosity are called into play in the process of learning and thinking. Jones, Wilkinson, and Braden (1961) showed that if individuals are deprived of information, they are more likely to seek it. Rosen, Siegelman, and Teeter (1963) studied individual differences in preference for "widely known" vs. "unknown" information. They found that the majority of college students, particularly

high verbal aptitude students, say they prefer new and "unknown" information. Students who said they preferred to learn "widely known" information tended to be other-directed and socially extraverted. Thus, "curiosity" may be thought of as an individual difference variable that may affect the individual's readiness to learn from meaningful verbal discourse. As McLaughlin (1965) pointed out, this is usually an uncontrolled variable in studies of incidental learning, so that it is difficult to draw any rigorous distinction between "intentional" and "incidental" learning. Salomon and Sieber (1970) showed organized and unorganized films to Ss under two types of instructions: To note information, and to form hypotheses about the topics dealt with in the films. They stated that organized films were more effective in arousing the kind of curiosity that allowed noting information, while unorganized films were more effective in prompting individuals to formulate hypotheses.

Achievement motivation, or "n Ach" as it is often abbreviated, refers to a generalized motive to attain success. Weiner (1967a) reviews current research in achievement motivation as it applies to school learning. This research suggests that individuals differ widely in both motivation to attain success and motivation to avoid failure, these being somewhat independent motives. Reconsideration of some aspects of J. Atkinson's model of the role of these motives in learning leads Weiner to think that learning situations challenge these motives best when the questions are neither too easy nor too hard, but are likely to be correctly answered about half the time. It should be noted that this suggestion conflicts with the principle of low error rates that often guides the construction of "programmed instruction" learning sequences. This latter principle is based on the assumption that the student will learn best when he is consistently rewarded; however, in the previous

chapter it was pointed out that current research on programmed instruction casts doubt on this assumption.

In another report, Weiner (1967b) concludes that motivation, not rehearsal, can itself account for the placement of items in short-term memory.

General achievement-motivation appears to interact with anxiety in some complex way. Russell (1952) failed to find any effect of experimentally-induced success-motivation on recall in a serial learning task, but he did find that anxiety, experimentally induced by telling Ss they were failing, had certain small effects. Kight and Sassenrath (1966) found that high achievement-motivated Ss performed better in a programmed instruction learning task. High-anxiety students worked faster and made fewer errors in learning than low-anxiety students, but they failed to exhibit higher retention scores. MacPherson (1967) also found that high-anxiety students took less time to complete a programmed course; this relationship between anxiety and time-to-complete was more pronounced for low IQ students. O'Neil, Spielberger, and Hansen (1969) found that anxiety, as measured by an inventory and also by blood-pressure measurements, increased as students were exposed to difficult materials and decreased with easy materials. Using Werner and Kaplan's (1950) context-learning task, Schmeidler, Ginsberg, Bruel, and Lukomnik (1965) also found complex interrelationships between anxiety, achievement motivation, and success in learning.

Levonian (1967) found that in the presentation of a film about safety, scenes which elicited high arousal and anxiety were recalled poorly on initial testing, but significantly better one week later. Low-arousal scenes, however, had precisely the opposite effect. Uhlmann (1962) found that retention of materials in meaningful verbal discourse was a function not only of their anxiety-arousing properties but also of certain "cognitive style"

characteristics of the learners, specifically their ability to "differentiate" stimuli as measured by the Embedded Figures and the Stroop Color-Word Tests. Schwartz (1967) investigated the differential properties of certain types of films in arousing "effectance motivation," defined as motivation to interact effectively with the environment (as opposed to lack of confidence in one's competence to do so).

These researches, despite their heterogeneity, are mentioned for their possible implications for future research on the role of motivation in learning from verbal discourse.

Attention. Attention, a state of heightened sensitivity to particular stimuli or sources of stimuli, is presumably a consequence of motivation, but it can be studied as an independent phenomenon. Wachtel (1967) has contributed a highly theoretical treatment of conceptions of broad and narrow attention. In a more practical vein, Fessenden (1955) speculated that listening may occur at seven levels of attention: (1) Isolation of sounds, words, etc. with no evaluation, (2) identification of meanings of sounds, words, etc.; (3) integration of perceptions with past experience; (4) inspection of the novel aspects of stimulation and the beginning of evaluation; (5) interpretation; (6) interpolation of one's own comments and reactions; (7) introspection as to the effect of the message on oneself. Whether it would actually be possible to identify such levels in some objective way is not indicated by Fessenden.

Muscle-tension during "attentive" listening was studied by Wallerstein (1954) through the use of electromyography. Muscle tension increased during the first hearing of a sequence from a detective story and even more so during the first hearing of a difficult philosophical passage from Kant.

By the third hearing when attention was presumably decreased, muscle tension also decreased; some subjects even went to sleep.

Bakan (1952) set up a "vigilance" condition whereby Ss had to listen for 90 minutes to apparently random digits in order to detect all instances of sequences of three odd digits. During a given 90-minute session, efficiency in this task tended to decrease; however, a slight practice effect was observed over the four days of the experiment.

Lumsdaine and May (1965) have reviewed various methods for measuring degree of attention during the watching of films. As far as the writer is aware, there are no studies of "attention" during reading, although there are obvious variations in attention during reading. Such variations can be controlled to some extent by instructions, as was pointed out in the previous chapter. We may mention here an interesting study by F. Taylor (1966), who had his subjects read a passage pertaining to the operation of a piece of psychological apparatus (a "dotting machine"). Some were told they merely had to pass a test on the operation of the machine, others were told they were going to have to operate the machine, and still others were told nothing about the purpose of their reading. All were then given both the written test and a performance test of operating the machine. Those told they were to take a test did well on the test but poorly on the machine; those told they would operate the machine did poorly on the test but well on the machine; those told nothing did poorly on both tests. Apparently the instructions determined what the subjects would pay attention to. The result for the group given no particular instructions seems to conflict with work on the "mathemagenic hypothesis" cited in the previous chapter, where it was noted that subjects not alerted to the kinds of tests they would perform tended to pay more attention to all aspects of a passage.

The so-called Von Restorff effect is sometimes cited as evidence that "isolation" of a unique item in a series causes S to pay closer attention to it and hence to recall it better. Green (1958) showed that the Von Restorff effect is due not to "isolation" but to change; i.e., whenever a new type of stimulus appears after a series of stimuli of another type, the first such stimulus is noticed and recalled better. On the strength of this finding, it may be possible to accentuate important stimuli in a series (which could be a series of sentences or other meaningful presentations) by making them the first of a series of stimuli of similar types.

It has been difficult to measure and control attention in classroom situations. Hudgins (1967) found it well-nigh impossible to detect from any observable behavior the actual amount of attention that children are giving to learning. He confirmed, however, the common assumption that children's attention in a recitation situation can best be maintained when the children are called on in random (rather than predictable) order and after (rather than before) the posing of a question (Hudgins and Gore, 1960).

Ginsburg (1967), working with Piagetian tasks, showed that there is an increase with age in the amount of information attended to in a display, and that the more specifically and efficiently a problem is posed to the subject, the more likely he will respond at his maximum level of attention and ability.

Other studies of set and attention that may be found relevant are those by Broadbent (1952a, 1952b, 1956, 1958), Reid and Travers (1968), and Talland (1958).

Study habits and attitudes. Stone (1965) conducted a study based on the hypothesis that study habits would affect students' performance in learning

from reading a text in the usual way, whereas they would not affect students' performance in learning from programmed instruction. He was not able to confirm this hypothesis; study habits were unrelated to performance in either type of instruction.

Two studies suggest that students' reading comprehension is affected by their attitudes towards the subject-matter (Jacobson and Johnson, 1967; Aaron and White, 1968).

Teaching Better Language Comprehension

Language comprehension is such a manifold and heterogeneous process, as has been demonstrated in this review, that attempts to "teach" listening and reading comprehension might be expected to have only indifferent success. Language development itself is such a slow and long-drawn process, particularly through the school years, that it is difficult to believe that special teaching programs of relatively short duration, say, a few weeks, could produce large gains. For example, to the extent that language comprehension depends upon a large vocabulary, brief programs of language improvement are unlikely to have substantial effects, because the rate at which new vocabulary can be taught and acquired are limited. Language improvement programs have been based on the assumption that significant effects can be produced by teaching particular skills, such as habits of listening attentively to perceive structural organization in speeches, that can be acquired in a relatively short time and that will make a difference of quantum magnitude in comprehension behavior.

Teaching listening comprehension. Several commercial programs for teaching listening skills are available, but research evidence supporting

their worth and effectiveness is scanty. Hollingsworth (1965) found, in a controlled experiment, no significant effects produced by the use, over a ten-week period, of the 30 tapes of the "Listen and Read" program of the Educational Development Laboratories. The dependent variable in this study was the score on the Listening test of the Sequential Tests of Educational Progress (STEP); one might question its appropriateness for measuring the skills presumably taught by the Listen and Read program.

A similar negative finding was reported by Gustafson and Shoemaker (1968) for another commercial program, Effective Listening. In one of their experiments, conducted with small numbers of adult subjects, the commercial program (taking 2 1/2 hours) yielded significantly larger gains than a 15-minute presentation of a printed summary of the points made in the program. But in another experiment, even though the program proved better than a tape-recorded summary and better than no treatment at all, the result was obtained only from "sanctioned test items furnished by the vendor," and not for other items of a similar nature constructed or selected by the investigators. The investigators consider that their findings cast doubt on the generality of the skills taught by the program.

Studies which have focused on particular skills and made use of training programs specially devised by the investigators have met with greater success. DeSousa and Cowles (1967, 1968) found significant effects, as measured by the STEP Listening test, of a 20-day program of training in "purposive listening" given to 7th-graders. The gains appeared both on an immediate posttest and on a test given one year after the training. Lundsteen (1970) obtained positive results from a training program that emphasized certain "critical thinking" skills. One of the experimental groups of 5th-

graders received training with a "listening emphasis" and its superiority showed up in certain specialized listening tests, but not on a test of general listening ability.

Other studies of the effects of listening training programs are summarized and annotated by Duker (1968). It would seem worthwhile to make analyses of precisely what listening skills seem to be teachable, with careful attention to the measurement of specific components of skill. Total scores, and even some subtest scores, on available listening tests do not seem to be homogeneous enough to permit one to draw precise conclusions about what skills are being measured, or what skills are improved (if any), in particular training programs.

Keislar and Stern's (1969) research narrowed its attention to the teaching of the aural comprehension, in first-graders, of certain linguistic units such as quantifiers (some, all, none) and expressions of negation, conjunction, disjunction, and joint denial. In comparison with control groups, their experimental groups made clear gains. They also investigated whether requiring the child to respond aloud in certain comprehension tasks would enhance the effect of the teaching program; the outcomes were positive for some concepts and neutral or even significantly negative for others. Interpretation of this result would require further research.

Teaching of reading comprehension. In this section we are not concerned with the large quantity of research on teaching "decoding" skills, i.e., teaching children to convert print into something corresponding to its oral representation, but rather with research having to do with the teaching of the comprehension of the message once it has been read. Seen in this light, the teaching of reading comprehension has many of the same problems that are inherent in the teaching of listening comprehension. The reading task does,

however, have the added dimension of speed, and many programs of reading improvement emphasize speed of comprehension, or even speed alone.

Research on the teaching of reading comprehension has been summarized and commented on in many places, e.g., by David Russell and Leo Fay in their chapter in the Handbook of Research on Teaching (Gage, 1963). Our consideration here will focus on several researches that illustrate specific problems.

One of the most perceptive essays on the teaching of reading comprehension is that by Black (1954). Black constructed a test of reading comprehension for students at a "training college" in England and analyzed the kinds of errors made on the test. The materials of the test were taken from general reading (essays, newspaper editorials, fiction, nonfiction) that an educated adult should be able to read. Black quotes some of I. A. Richards' rather pessimistic conclusions concerning the ability of adults to read such material with understanding and insight; although he is not as pessimistic as Richards, his results do show considerable deficiences in understanding among "training college" students who would be comparable to undergraduate teacher trainees in this country. Errors are classified into the following categories:

Failures to understand a writer's intention
Failures to detect irony
Ignorance or misunderstanding of difficult words
Ignorance or misunderstanding of difficult allusions
Not understanding illustrative examples or metaphors
Errors due to students' inadequate background information
Failures to see how the context influences meaning
Errors due to readers' preconceptions

With the possible exception of those due to ignorance or misunderstanding of "difficult words," these errors cannot be put down to lack of understanding of language as such. They seem to be due mainly to deficiencies in the student's

general educational background, deficiencies that can be made up only by wide reading and broader education. Programs designed to teach "reading comprehension" at the college level are attempting to do something that is well-nigh impossible in the time available to them--to give the student a general education. Although the student may be helped over his difficulties by some hints and special coaching and even some specific information about allusions, hard words, and unusual examples as they come up in reading, it is unrealistic to expect "remedial" reading programs at the college level to "make over a student's mind." This is perhaps the reason why these programs seem to have had such limited success.

It is reasonable to think that at lower age levels a good deal can be done with specific training in vocabulary, grammatical analysis, and the teaching of concepts. Lieberman (1967) obtained significant gains on the Iowa Reading Test and a special vocabulary test adapted from those used on certain intelligence tests, through a program designed to teach vocabulary concepts "emphasizing auditory, visual, and tactile experience." Similarly, Jacobson, Yarborough, and Hanbury (1968) had "encouraging" results with a year-long program of vocabulary study designed to improve reading, writing, and listening skills and verbal abilities in general, at the high-school level.

Allen (1964) recommends a program of training that makes use of his "sector analysis" grammar to help elementary school children analyze and comprehend sentences more adequately. No research seems to have been reported concerning the effectiveness of such a program. Reed (1966) developed a program of reading instruction for grade 7 based on recognition of sentence elements and paragraph structure. In a controlled experiment she found that the program yielded gains in experimental groups over those of control groups,

but her results show that the gains were made principally by bilingual children, very little by monolingual children.

Reading improvement programs have most often been designed to increase pupils' reading rate. The assumption seems to have been that improved comprehension will result in some magical way from improved reading rate. There has been much misunderstanding concerning the relation between rate and comprehension (Blommers and Lindquist, 1944). From the fact that measures of rate and of comprehension are often found to have substantial inter-correlations, it does not follow that improvement in rate will produce improvement in comprehension. This issue has been discussed perceptively by Harris (1968), who states that research has generally not shown gains in comprehension as a result of reading-speed improvement programs. Students who appear to attain high reading speeds in commerical reading programs seldom if ever show comparable improvement in comprehension; comprehension is often less than 50% of that at slower speeds. Berger (1967) found no significant improvement in comprehension in any of his college-freshman reading-improvement groups. He found that rate increases occurred in all four of his groups--whether taught by a tachistoscopic method, a controlled reader method, controlled pacing, or simply practice in paperback scanning, and that these rate increases held up after 8 weeks. He pointed out that greater gains in rate were obtainable by a simple method--paperback scanning--than by the other methods he investigated, each requiring the use of special expensive equipment.

The finding that comprehension does not improve along with improvements in reading rate and flexibility might have been expected in view of the fact that improving comprehension would entail attention to the language difficulties

in material and to the logical and inferential behavior that is involved in high levels of comprehension. We can make reference again to the study of Lundsteen (1970), who found that training in critical reasoning produced gains in comprehension scores on reading tests given to 5th-grade children. The experiment of Bridges (1941) with pupils at the 4th, 5th, and 6th grades may also be cited as showing that gains in comprehension accrue when special efforts to teach comprehension are made. Bridges found, in fact, that training that emphasized comprehension rather than speed was more effective in developing both speed and comprehension than was training that emphasized speed and minimized comprehension. In the light of some of the research cited in Chapter 7, Bridges' methods of teaching comprehension may not have been optimal. She used daily comprehension exercises that presented pupils with questions before the reading selections; the children were to "read to find the answers" and were then permitted to check their answers. According to the work summarized by Frase (1970a), more effective reading habits might have been engendered by putting the questions after the reading selections. An issue left open by Frase's research, however, is that of whether permitting students to re-read the material to check their answers would have increased comprehension even further.

It may be suggested that in the planning of research, the salient need is to determine exactly what practices in the teaching of comprehension will make this teaching optimally effective. Additional studies of the overall effectiveness of ill-defined programs will be of little value. This remark applies to the teaching of comprehension generally, both in the listening and reading areas.

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